Scheme and Syllabus

of

B. Tech. VLSI Design and Technology

(2024-2025 onwards)

Offered by:

Department of Electronics & Communication Engineering

NATIONAL INSTITUTE OF TECHNOLOGY DELHI

Delhi-110036, INDIA

(An autonomous Institute under the aegis of Ministry of Education, Govt. of India)

*Approved in the 3rd Meeting of Board of Studies of the Dept. of ECE, held on February 23, 2024, further in line with the recommendation of the 4th Meeting of Board of Studies of the Dept. of ECE held on January 17, 2025 and finally in line with the recommendation of the Honourable Senate in the 18th Senate Meeting held on February 12, 2025.

Department of Electronics and Communications Engineering
National Institute of Technology Delhi

1.1 About the Department

Department of Electronics and Communication Engineering (ECE), National Institute of Technology Delhi was established in 2010, immediately with the beginning of the Institute under the aegis of the Ministry of Human Resource and Development (MHRD), Govt. of India. Currently, the Department offers two Undergraduate Programs B. Tech (ECE) & B. Tech (VLSI Design and Technology). The department offers two postgraduate programs, one of which is M. Tech. ECE and the other is M. Tech. ECE (VLSI). The Department also offers a Ph.D. and Post-Doctoral Fellowship (PDF) Programme in relevant areas. The department has excellent laboratories and research facilities in electronic devices and circuits, electronic measurement and instrumentation, microprocessor and microcontroller, microwave and antenna design, VLSI design, optical fibre and optical devices, multimedia, and advanced communication and design automation and simulation laboratory. The Department has received projects, grants, and fellowships from the Ministry of Electronics and Information Technology (MeitY), the Department of Science and Technology (DST)-SERB, and other funding agencies. The Department has active collaborations with academic Institutes & research institutes in India and abroad.

The Department of ECE has a blend of young and experienced dynamic faculty members and is committed to providing quality education and research in the field. Faculty members of the department have excellent academic & research credentials and have published numerous peer-reviewed journal articles/papers, Books, Book Chapters, etc., in the diversified field and have adequate experience in advanced research. The department of ECE provides a creative learning environment for students to excel in technical education. Here, the students learn to face the challenges related to emerging technologies in electronics and communication engineering. The department of ECE promotes a self-learning attitude, entrepreneurial skills, and professional ethics. The department hopes to achieve the national goals and objectives of industrialization and self-reliance. As a result, it hopes to produce graduates with strong academic and practical backgrounds so that they can fit into the industry immediately upon graduation.

1.2 Vision

Create an educational environment to prepare the students to meet the challenges of the modern electronics and communication industry through state-of-the-art technical knowledge and innovative approaches beneficial to society.

1.3 Mission

- To promote teaching and learning by engaging in innovative research and offering state-of-the-art undergraduate, postgraduate, and doctoral programs.
- To cultivate an entrepreneurial environment and industry interaction, leading to the emergence of creators, innovators, and leaders.
- To promote co-curricular and extra-curricular activities for the overall personality development of the students.
- Building of responsible citizens through awareness and acceptance of ethical values.

B. Tech. in VLSI Design and Technology

2.1 Preamble

B. Tech. (VLSI Design and Technology) program offered at NIT Delhi is designed to equip students with a unique blend of skill sets that include:

- Strong theoretical foundation
- Predominantly practice-oriented approach with access to well-equipped and specialized laboratories and supervised internship
- Hands-on technical training
- Life skills orientation
- Hard and soft skills
- Business perspective, along with an emphasis on innovation and entrepreneurship

2.2 Salient Features

- Minimum Credits requirements for completion of B.Tech. Program is 160.
- The Curriculum is based on the National Education Policy (NEP) – 2020 guidelines.
- The curriculum has embedded the Multi Exit/ Multi Entry in the B. Tech. program.
- Students are provided with a major degree and a minor degree.
- The curriculum is designed to meet the prevailing and ongoing industrial requirements.
- The curriculum includes Project-based Education with Projects every year.
- The flexible curriculum offers a Choice Based Credit System (CBCS).
- The curriculum inherits Value-based Education and offers Interdisciplinary/ Multidisciplinary Courses.
- The Curriculum offers Digital Pedagogy & Flipped Learning with adequate motivation for Entrepreneurship/ Start-ups.
- The curriculum aims to develop the students holistically.

2.3 Cardinal Mentions

- Students exiting after completing 1st Year, 2nd Year, and 3rd Year will be awarded a Certificate, Diploma, and Advanced Diploma in VLSI Design and Technology, respectively. The minimum Credit requirement for a Certificate is 40 Credits, a Diploma is 80 Credits, and an Advanced Diploma is 120 Credits respectively.
- The students can opt for a Minor Degree across any specialization offered in the Institute from the 5th Semester, e.g., a student pursuing B. Tech. (VLSI Design and Technology) may opt for Minor Degrees offered by the different Departments in the Institute depending upon his/her interest.
- The students opting for a Minor Degree will have to earn additional credits for the Minor Degree as per Institute norms, which may vary from time to time.

2.4 Program Educational Objectives (PEOs)

PEO-1	To design and develop innovative and cost-effective electronic systems exhibiting strong foundations and core competencies in microelectronics, embedded systems, and chip design.
PEO-2	To adapt the emerging technologies, provide solutions to global challenges, pursue higher studies, industrial and R&D requirements, become entrepreneurs.
PEO-3	To develop the aptitude for innovation, teamwork, and leadership with effective communication skills to work in a multidisciplinary and multicultural environment.
PEO-4	To exhibit strong professional ethics and values for social and environmental sustainability with a focus on the welfare of humankind.

2.5 Program Outcomes (POs)

PO-1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO-4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern Tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO-6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO-11	**Project Management and Finance:** Demonstrate knowledge and understandin5g of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

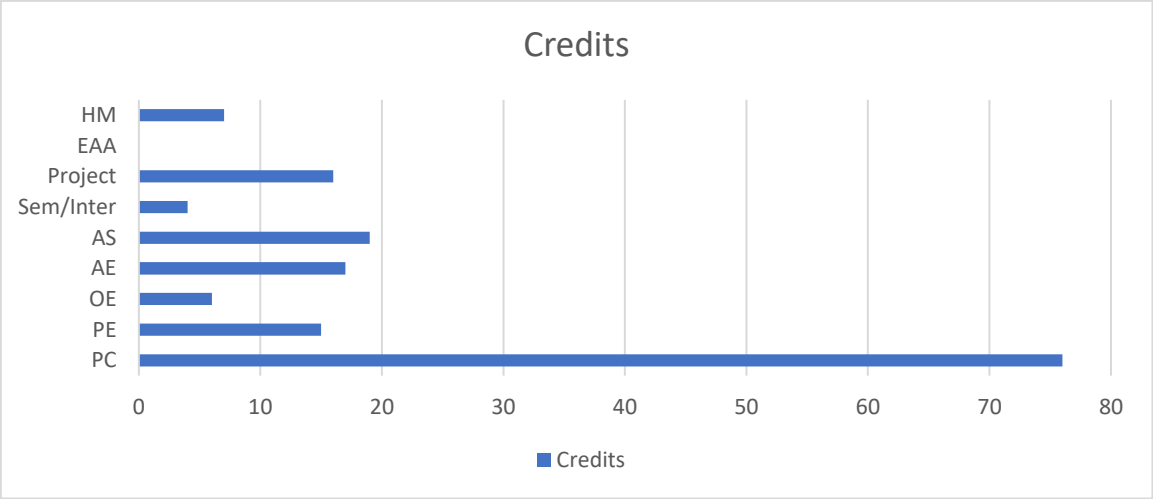
2.6 Program Specific Objectives (PSOs)

PSO -1	Capability to design integrated circuits (ICs) to develop innovative and cost-effective electronic systems for a sustainable semiconductor ecosystem.
PSO -2	An ability to use acquired technical knowledge for a successful career and contribute to research and entrepreneurship, especially in the IC design and technology domain.

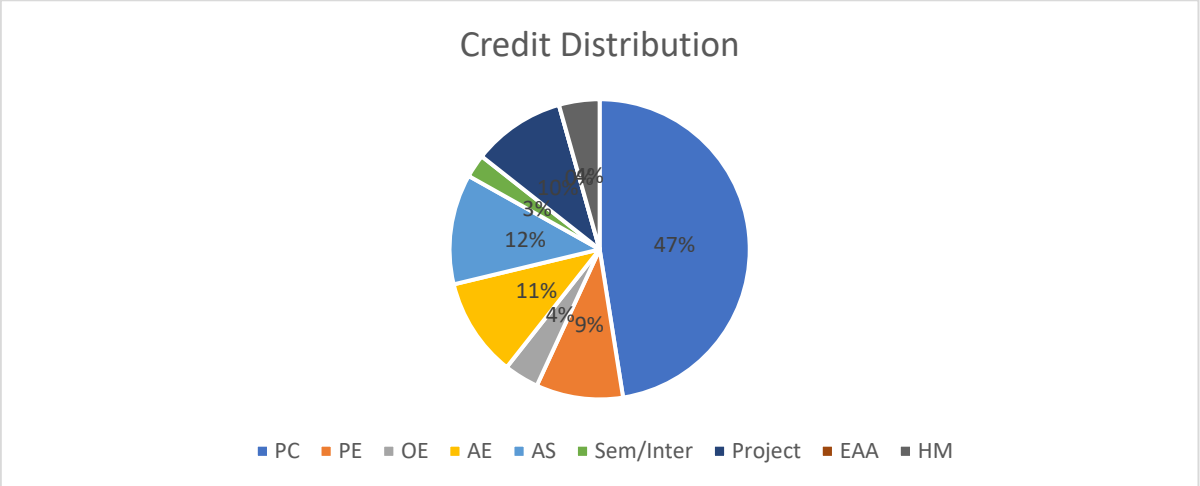
3.1 Semester-wise Credit Structure

Sl. No.	**Category of Courses**	**1st Year**		**2nd Year**		**3rd Year**		**4th Year**		**Total**
		Semester I	**Semester II**	**Semester III**	**Semester IV**	**Semester V**	**Semester VI**	**Semester VII**	**Semester VIII**	
1.	Program Core	--	08	12	20	17	14	05	0	76
2.	Program Electives	--	--	--	--	03	03	09	--	15
3.	Open Electives						03	03		06
4.	Allied Engineering	08	04	05	--	--	--	--	--	17
5.	Applied Sciences	08	08	03	--	--	--	--	--	19
6.	Seminar / Summer Internships/ Independent Study and Seminar	--	--	--	--	--	---	--	04	04
7.	Project	--	--	--	--	--	--	--	16	16
8.	Extra Academic Activity	--	--	--	--	--	--	--	--	--
9.	Humanities	04	--	--	--	--	--	03	--	07
Total		20	20	20	20	20	20	20	20	160

3.2 Credits Distribution



3.3 Credits Distribution (%)



Course Coding Pattern

- Numeric code (XXX) - First digit for semester and rest two for course number
- EC- Program Core
- PE – Program Elective
- AE – Allied engineering
- MA – Mathematics (Applied Science)
- PH – Physics (Applied Science)
- CY – Chemistry (Applied Science)
- HM- Humanities and Management
- HSP - Extra Academic activity
- V- VLSI, L- Lecture, P- Practical/Project, B- Both.

Teaching Scheme
For
B. Tech VLSI Design & Technology

Semester I						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
MAVL101	Mathematics-I	Applied Sciences	3	1	0	4
CYVB 102	Engineering Chemistry	Applied Sciences	3	0	2	4
CELB 101	Environmental Sciences	Allied Engineering (CE)	2	0	0	2
MEVP 102	Engineering Graphics and Design	Allied Engineering (ME)	1	0	2	2
EEVB 103	Basics of Electrical and Electronics Engineering	Allied Engineering (EE)	3	0	2	4
HMVB 101	Human Values and Ethics	Humanities and Management	2	0	2	3
HMVP 102	Technical Communication	Humanities and Management	0	0	2	1
Total Credits			13	1	12	**20**

Semester II						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
MAVL 203	Mathematics - II	Applied Sciences	3	1	0	4
PHVB 204	Engineering Physics	Applied Sciences	3	0	2	4
CSVB 204	Problem Solving and Computer Programming	Allied Engineering (CSE)	3	0	2	4
MAVL 205	Probability Theory and Stochastic Process	Applied Science	3	0	0	3
ECVL 201	Basics of Semiconductor Materials	Program Core	3	1	0	4
HSPB 151	Holistic Health & Sports	Extra Academic Activity	0	0	2	1
Total Credits			15	2	6	**20**

Semester III						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECVB 302	Electronic Devices and Circuits	Program Core	3	0	2	4
ECVB 303	Signals and Systems	Program Core	3	0	2	4
ECVB 304	Digital Electronics	Program Core	3	0	2	4
EEVL 305	Network Analysis and Control Theory	Allied Engineering (EE)	3	1	0	4
CSVB 306	Data Structure and Programming	Allied Engineering (CSE)	3	0	2	4
Total Credits			15	1	8	**20**

Semester IV						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECVB 405	Micro Fabrication Technology	Program Core	3	0	0	3
ECVB 406	Digital System Design	Program Core	3	0	2	4
ECVB 407	Analog Communication	Program Core	3	0	2	4
ECVB 408	Microprocessors and Microcontrollers	Program Core	3	0	2	4
ECVB 409	Digital Signal Processing	Program Core	3	0	2	4
ECVP 410	Mini Project	Program Core	0	0	2	1
Total Credits			15	0	10	**20**

Summer Internship (6-8 weeks) is mandatory during the summer vacation in between semester IV and V for each student to continue the programme and the corresponding evaluation will take place in the next semester (semester V).

Semester V						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECVB 511	Digital Communication	Program Core	3	0	2	4
ECVB 512	Digital VLSI Design	Program Core	3	0	2	4
ECVB 513	Semiconductor Packaging and Testing	Program Core	3	0	0	3
ECVB 514	Algorithm for VLSI Design	Program Core	3	0	0	3
PEVL**XXX**	Elective-I	Program Elective	3	0	0	3
ECVP 515	Programming Lab	Program Core	0	0	4	2
ECVP 516	Seminar/ Summer Internship-I	Program Core	0	0	2	1
Total Credits			15	0	10	**20**

Semester VI						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECVB 617	Embedded and Real-Time Operating Systems	Program Core	3	0	2	4
ECVB 618	Analog VLSI Design	Program Core	3	0	2	4
PEVL**XXX**	Elective-II	Program Elective	3	0	0	3
PEVL**XXX**	Elective-III	Program Elective	3	0	0	3
OEVL	Open Elective-I / MOOCs	Open Elective	3	0	0	3
ECVP 619	Minor Project	Program Core	0	0	4	2
ECVP 620	Project-based learning	Program Core	0	0	2	1
Total Credits			15	0	10	**20**

Summer Internship (6-8 weeks) is mandatory during the summer vacation in between semester VI and VII for each student to continue the programme and the corresponding evaluation will take place in the next semester (semester VII).

Semester VII						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECVL 721	Low Power VLSI Design	Program Core	3	0	0	3
ECVL 722	VLSI Verification & Testing	Program Core	3	0	2	4
PEVL**XXX**	Elective-IV	Program Elective	3	0	0	3
PEVL**XXX**	Elective-V	Program Elective	3	0	0	3
OEVL**XXX**	Open Elective-II / MOOCs	Open Elective	3	0	0	3
HMVL 703	Engineering Economics and Accounting	Humanities and Management	3	0	0	3
ECVP 723	Seminar/ Summer Internship-II	Program Core	0	0	2	1
Total Credits			18	0	4	**20**

Semester VIII						
Course Code	**Course Name**	**Type**	**L**	**T**	**P**	**Credit**
ECVP 824	Major Project/Internship	Program Core	-	-	-	16
ECVP 825	Independent Study & Seminar	Program Core	-	-	8	4
Total Credits						**20**

***Open electives are such subjects which will be offered by other departments. ECE department students have to opt open electives from CSE, EE and other departments.**

List of Electives

Bouquet 1: Elective-I

S. No.	Course Code	Course Title	L	T	P	Credits
1.	PEVL 501	Semiconductor Device Modelling	3	0	0	3
2.	PEVL 502	Introduction to Machine Learning	3	0	0	3
3.	PEVL 503	Internet of Things	3	0	0	3
4.	PEVL 504	Wireless Communication	3	0	0	3
5.	PEVL 505	Digital Signal Processor and Architecture	3	0	0	3
6.	PEVL 506	Antenna Theory and Design	3	0	0	3

Bouquet 2: Elective-II and Elective III

S. No.	Course Code	Course Title	L	T	P	Credits
1.	PEVL 607	Introduction to MEMS	3	0	0	3
2.	PEVL 608	Nano Electronics	3	0	0	3
3.	PEVL 609	Cyber Security	3	0	0	3
4.	PEVL 610	ASIC and FPGA Design	3	0	0	3
5.	PEVL 611	Radar Engineering	3	0	0	3
6.	PEVL 612	Advance Neural Network	3	0	0	3
7.	PEVL 613	VLSI Interconnects	3	0	0	3
8.	PEVL 614	AI and Machine Learning for IC	3	0	0	3
9.	PEVL 615	VLSI for Communications	3	0	0	3
10.	PEVL616	Memory Devices and circuits	3	0	0	3

Bouquet 3: Elective-IV and Elective V

S. No.	Course Code	Course Title	L	T	P	Credits
1.	PEVL 717	CAD for VLSI	3	0	0	3
2.	PEVL 718	Thin Films Characterization	3	0	0	3
3.	PEVL 719	Mixed Signal IC design	3	0	0	3
4.	PEVL 720	Bio-Medical Electronics	3	0	0	3
5.	PEVL 721	RF Microelectronics	3	0	0	3
6.	PEVL 722	High-Speed Interfacing Circuits	3	0	0	3
7.	PEVL 723	Digital Image Processing	3	0	0	3
8.	PEVL 724	Flexible Electronics	3	0	0	3
9.	PEVL 725	Quantum Computing	3	0	0	3
10.	PEVL 726	Solar Cell Technology	3	0	0	3
11.	PEVL 727	Ad-hoc Sensor Networks	3	0	0	3
12.	PEVL 728	Full Custom Design	3	0	0	3
13.	PEVL 729	Advance Semiconductor Manufacturing	3	0	0	3
14.	PEVL 730	Data Converters	3	0	0	3
15.	PEVL 731	Reconfigurable Computing System and Applications	3	0	0	3

Open Elective-I

S. No.	Course Code	Course Title	L	T	P	Credits
1.	OEVL 601	Growth, Fabrication and Manufacturing of Electronic Devices	3	0	0	3
2.	OEVL 602	Electronic Materials	3	0	0	3
3.	OEVL 603	Basics of IC Design	3	0	0	3

Open Elective-II

S. No.	Course Code	Course Title	L	T	P	Credits
1.	OEVL 704	Data Communication and Networking	3	0	0	3
2.	OEVL 705	Micro-Electronics and VLSI Technology	3	0	0	3
3.	OEVL 706	Embedded and real time operating systems	3	0	0	3

Proposed List of Massive Open Online Courses (MOOCs):

Students can opt for the MOOCs related to VLSI/Embedded Systems. A suggestive list is given below, and students need to opt for MOOCs related to a UG Degree. The Chairman DBoS may vary the following list of subjects as per the student's and teaching requirements.

S. No.	Suggested MOOCs	Course Duration	Credit points	Category
1.	VLSI Design Flow: RTL to GDS	12 Weeks	3	ECE/VLSI
2.	Semiconductor Devices and Circuits	12 Weeks	3	ECE / VLSI Design
3.	Real-Time Digital Signal Processing	12 Weeks	3	ECE / Communication and signal processing
4.	Photonic Crystals: Fundamentals & Applications	12 Weeks	3	ECE / Photonics
5.	Phase-Locked Loops	12 Weeks	3	ECE / VLSI Design
6.	Microelectronics: Devices to Circuits	12 Weeks	3	ECE / VLSI Design
7.	Fundamentals of Nano and Quantum Photonics	12 Weeks	3	ECE / Photonics
8.	Enclosure Design of Electronics Equipment	12 Weeks	3	ECE
9.	Design of Photovoltaic Systems	12 Weeks	3	ECE

SEMESTER-I

Course Code: MAVL 101	**Applied Science course: (Y/N)**	**HM Course: (Y/N)**	**PC Course: (Y/N)**	**PE Course: (Y/N)**
	Y	N	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**MATHEMATICS - I**			
Course Coordinator				
Course Objectives	To build fundamental knowledge to solve mathematical problems of calculus and Geometry			

Course Outcomes		**Cognitive Levels**
CO1	Understand the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions.	Understand (Level-II)
CO2	Understand the fundamentals of series and sequence theorems.	Understand (Level-II)
CO3	Apply the differential equations to calculus in the multivariable domain.	Apply (Level -III)
CO4	Apply the Integral equations to calculus in the multivariable domain.	Apply (Level -III)

Semester	**1st**	**Autumn**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	1	0	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Engineering Mathematics
	Author	Reena Garg
	Publisher	Khanna Book Publishing Company
	Edition	2022
2.	Title	Reena Garg
	Author	Advanced Engineering Mathematics
	Publisher	Khanna Book Publishing Company
	Edition	2021
Reference Books		
1.	Title	Calculus and Analytic geometry
	Author	G.B. Thomas and R.L. Finney
	Publisher	Pearson
	Edition	2002

Course Contents	**UNIT I:** Basic Calculus: Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Single-variable Calculus (Differentiation): Rolle's Theorem, Mean	**9**

	value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L'Hospital's rule.	
	UNIT II: Sequences and series: Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.	**9**
	UNIT III: Multivariable Calculus (Differentiation): Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.	**9**
	UNIT IV: Multivariable Calculus (Integration): Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to polar), Applications: areas and volumes, Centre of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: CYVB 102	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N

Type of Course	Theory Course and Lab Course
Course Title	**ENGINEERING CHEMISTRY**
Course Coordinator	
Course Objectives	To provide fundamental knowledge of chemical structure and properties.

Course Outcomes		**Cognitive Levels**
CO1	To understand chemical bonding in the molecules and complexes.	Understand (Level-II)
CO2	To analyze the ranges of the electromagnetic radiation used for exciting different molecular energy levels in various spectroscopic techniques.	Analyze (Level-IV)
CO3	To understand thermodynamic and electrochemical concepts.	Analyze (Level-IV)
CO4	To understand periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.	Apply (Level-III)

Semester	**1st**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Inorganic Chemistry: Principles of Structure and Reactivity
	Author	J. E. Huheey
	Publisher	Pearson
	Edition	4th
2.	Title	Concise Inorganic Chemistry
	Author	J. D. Lee
	Publisher	Wiley India
	Edition	5th
3	Title	Organic Chemistry
	Author	Bruice Yurkanis Paula
	Publisher	Pearson Education India
	Edition	7th
Reference Books		
1.	Title	Physical Chemistry
	Author	P. W. Atkins
	Publisher	Oxford
	Edition	10th

Course Contents	**UNIT I:** Chemical Bonding: Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shall electron pair repulsion (VSEPR) theory. Crystal Field Theory (CFT), comparison of the stability of octahedral and tetrahedral complexes on the basis of crystal field stabilization energy (CFSE), factor affecting the magnitude of CFSE, application of crystal	**10**

	field theory. Jahn-Teller effect definition and example from d^9 and high spin d^4 systems.	
	UNIT II: Spectroscopic techniques and applications: Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications. Vibrational and rotational spectroscopy of diatomic molecules and applications. Nuclear magnetic resonance and magnetic resonance imaging.	**10**
	UNIT III: Use of free energy in chemical equilibria: Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, oxidation reduction reaction, Nernst equation and applications.	**08**
	UNIT IV: Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases.	**08**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments	1. To find the strength in grams per litre of the given solution of sodium hydroxide with the help of stander oxalic acid solution. 2. ESTIMATION OF WATER HARDNESS BY EDTA METHOD (a) To determine the strength of calcium ion in given $CaCO_3$ solution by Complexometric Titrations. (b) To determine the strength of magnesium ion in given $MgSO_4$ solution by Complexometric Titrations. (c) To determine the total hardness of given water sample by Complexometric Titrations. 3. To determination the strength of ferrous ammonium sulphate with the help of $K_2Cr_2O_7$ solution. 4. To synthesize copper ammonium complex. 5. To synthesize $[Cu(H_2O)_6](ClO_4)_2$ complex. 6. Order of a reaction (redox). 7. Blue printing. 8. Acid-base titration using pH meter. 9. Acid-base titration by conductometry. 10. Determination of Fe(III) by colorimetry	

Course Code: CELB 101	Allied Engineering Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N

Type of Course	Theory Course/ Lab Course
Course Title	**ENVIRONMENTAL SCIENCE**
Course Coordinator	
Course Objectives	To provide fundamental knowledge environmental science to solve environment related problems.

Course Outcomes		**Cognitive Levels**
CO1	Gain a comprehensive understanding of the Environmental Science aspects.	Understand (Level-II)
CO2	Develop awareness of environment related issues.	Analyze (Level-IV)
CO3	Learn about the ethical and moral responsibilities of the engineers towards environment.	Understand (Level-II)
CO4	Learn remedial measures to solve environmental issues.	Understand (Level-II)

Semester	**1st**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	2	0	0	2	**24**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Introduction to Environmental Engineering
	Author	Mackenzie L. Davis and David A. Cornwell.
	Publisher	Tata McGraw-Hill Education Private Limited
	Edition	4rth edition 2010
2.	Title	Introduction to Environmental Engineering and Science
	Author	Gilbert M. Masters
	Publisher	Pearson Education
	Edition	2nd edition 2007
Reference Books		
1.	Title	Environmental Science and Engineering
	Author	J. Glynn Henry and Gary W. Heinke
	Publisher	Pearson Education
	Edition	2nd edition 2004

Course Contents	**UNIT I:** Multidisciplinary nature of environmental studies, Definition, scope and importance, need for public awareness. Ecosystems - Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems: - a. Forest	**12**

	ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems, Biogeochemical cycles	
	UNIT II: Biodiversity and its conservation Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation, Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity	**8**
	UNIT III: Environmental Pollution Definition, Cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. nuclear hazards, Causes, effects and control measures of urban and industrial wastes. Pollution case studies. Solid waste Management.	**8**
	UNIT IV: Social Issues and the Environment, From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Climate change, global warming, acid rain, ozone layer depletion and Eutrophication.	**8**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: MEVP 102	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**ENGINEERING GRAPHICS & DESIGN**			
Course Coordinator				
Course Objectives	The objective of this Course is to provide the basic knowledge about Engineering Drawing.			

Course Outcomes		**Cognitive Levels**
CO1	To Understand the concept of Engineering Graphics.	Understand (Level-II)
CO2	Apply the concept of engineering drawing to draw the various geometrical shapes.	Apply (Level-III)
CO3	Apply the concepts are given in projections, technical drawing,	Apply (Level-III)
CO4	Design team project that illustrates Geometry and topology of engineered components using CAD.	Evaluate (Level-V)

Semester	**1st**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	1	0	2	2	**24**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Engineering Graphics & Design
	Author	Pradeep Jain
	Publisher	Khanna Book Publishing
	Edition	
2.	Title	Engineering Graphics & Design
	Author	Jain, Maheshwari, Gautam
	Publisher	Khanna Book Publishing
	Edition	
Reference Books		
1.	Title	Engineering Drawing
	Author	N.D.Bhatt, V.M. Panchal &P.R., Ingle
	Publisher	Engineering Drawing
	Edition	

Course Contents		
	UNIT I: **Introduction to Engineering Graphics & Design: Drawing:** Principles of Engineering Graphics and their significance, usage of Drawing instruments, Lettering. Computer Graphics: Engineering Graphics Software - Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling.	**6**
	UNIT II:	**6**

	Engineering Scales & Curves: Types of scales-Plain scale, Diagonal scale, Conic sections, Cycloid, Epicycloid, Hypocycloid, Spiral and Involute**.** Orthographic Projections: Principles of Orthographic Projections-Conventions - Projections of Points, Lines and Plane.	
	UNIT-III **Projections of Solids:** Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans. Sections and Sectional Views of Right Angular Solid Prism, Cylinder, Pyramid, Cone – Auxiliary Views, Sectional views of Right Regular Solids-Prism, Pyramid, Cylinder and Cone. **Isometric Projections:** Principles of Isometric projection – Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.	**6**
	UNIT-IV **CAD Modelling:** Overview of Computer Graphics, theory of CAD, important commands and their uses. Customisation & CAD Drawing, setting up of Modules and drawing limits; ISO and ANSI standards, tolerance; Annotations, Layering, applying annotations to drawings; Printing documents; orthographic projection techniques; Drawing sectional views of different objects, CAD modelling of parts and assemblies, surface, and wireframe models, Dimensioning guidelines, tolerance techniques; dimensioning and scale multi views of dwelling.	**6**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: EEVB 103	Allied Engineering Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING**			
Course Coordinator				
Course Objectives	The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.			

Course Outcomes		**Cognitive Levels**
CO1	Understand basics of semiconductor theory and principle of diode operation.	Understand (Level-II)
CO2	To study the design and operation of rectifiers and transistor amplifiers.	Apply (Level-III)
CO3	To study and apply circuit theorems to AC and DC circuits.	Apply (Level-III)
CO4	Understand and analyses the working principles of electrical machines.	Analyze (Level-IV)

Semester	**1st**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

Text Books

1.	Title	Basic Electrical Engineering
	Author	Ritu Sahdev
	Publisher	Khanna Book Publishing
	Edition	2022
2.	Title	Basic Electrical Engineering
	Author	Nagrath I.J. and D. P. Kothari
	Publisher	McGraw-Hill Education
	Edition	2001

Reference Books

1.	Title	Engineering Circuit Analysis,
	Author	Hayt and Kimberly
	Publisher	Tata McGraw Hill
	Edition	8th edition 2013

Course Contents	**UNIT I:** Conductivity of insulators, metals, and semiconductors in terms of energy bands, the chemical bond in Si and Ge, conductivity of intrinsic semiconductors, extrinsic semiconductors: n-type and p-type semiconductors, Hall Effect in semiconductors, Mechanism in current flow: drift and diffusion, Einstein relation, semiconductor materials: Element semiconductor, II-VI compound, III-V compounds, ternary and quaternary compounds. V-I characteristics of PN-junction diode. Diode equivalent circuit, diode as a switch, diode testing.	**9**

	UNIT II: Rectifiers: Half wave, center tapped and bridge full-wave, Zener diode regulator and voltage multiplier, clipping and clamping circuits. TRANSISTORS: Construction and characteristics of BJT, Transistor configuration: CB, CE, CC configuration, Transistor at low frequency, small signal low-frequency transistor model(h-parameters), Analysis of transistor amplifier using h-parameters, Transistor biasing and bias stabilization: Operating point, Stability factor, Analysis of fixed bias, collector to base bias, Emitter resistance bias circuit and self-bias circuit, Bias compensation techniques.	**9**
	UNIT III: Voltage and current sources, dependent and independent sources, source conversion, DC circuit's analysis using mesh & nodal method, Thevenin's& superposition theorem, star-delta transformation. 1-phase AC circuits under sinusoidal steady-state, active, reactive, and apparent power, physical meaning of reactive power, power factor, 3-phase balanced and unbalanced supply, star and delta connections.	**9**
	UNIT IV: Transformers: Magnetic Circuits: Review of laws of electromagnetism, Flux, MMF and their relation, analysis of the magnetic and electric circuit. Single-phase transformer: Basic concepts, constructional features, EMF equation, voltage, current, and impedance transformation, Equivalent circuits. Electrical Machines: DC Machines: Constructional features, working principle, emf equation, types of dc machines, and their characteristics. Induction Machines: Constructional features, working principle, emf equation, the concept of slip and torque–slip characteristics. Synchronous Machines: Constructional features, working principle and emf equation.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments	1. To verify KCL and KVL 2. To study the V-I characteristics of an incandescent lamp. 3. To measure single phase power by using three ammeter method. 4. To measure the single-phase power by using three voltmeter method. 5. To perform short circuit test on a single-phase transformer. 6. To perform open circuit test on a single-phase transformer. 7. To measure three phase power by using two wattmeter method. 8. To study the PN Junction diode characteristics. 9. To design the half wave and full wave rectifiers circuits. 10. To study CB, CE, CC input and output characteristics.	

Course Code: HMVB 101	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**HUMAN VALUES AND ETHICS**			
Course Coordinator				
Course Objectives	To give the fundamental knowledge of ethical practice and human values.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the Organization and Organizational behaviour.	Understand (Level-II)
CO2	Understand the emotion, feeling, authority and responsibility.	Understand (Level-II)
CO3	Develop the moral and ethical values.	Apply (Level-III)
CO4	Analyze the policy of human resources.	Analyze (Level-IV)

Semester	**1st**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	2	0	2	3	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Organizational Behaviour: Text and Cases
	Author	A.K. Chitale, R.P. Mohanty and N.R. Dubey
	Publisher	PHI Learning Private Limited
	Edition	2019
2.	Title	Text & Cases in Human Resources Management
	Author	K. Ashwathappa
	Publisher	Tata McGraw Hill
	Edition	2012

Reference Books		
1.	Title	Engineering Ethics includes Human Values
	Author	M. Govindarajan, S. Nataraja and V.S. Senthil Kumar
	Publisher	PHI Learning Pvt. Ltd
	Edition	2011

Course Contents		
	UNIT I: Introduction: Organization and Organizational Behaviour- Concept and significance, Organizational Structures, Individual & Group Behaviour; Morals, Values and Ethics; Engineering Ethics- Need, Scope, and Approach; Personality- meaning and definition, Types of Personality; Personality Attributes; Determinants of Personality- Biographical and Personal factors, Environmental Factors, Psychological Factors; Big Five Personality traits.	**9**
	UNIT II: Feelings, Classification of Feelings; Dimensions of Emotions, Emotions and External Constraints; Emotional Intelligence; Spiritual Intelligence; Authority, Responsibility and Accountability: Meaning of Authority, Responsibility and	**9**

	Accountability, Balance between Authority, Responsibility and Accountability.	
	UNIT III: Moral Development; Variety of Moral Issues; Moral Dilemma; Moral Autonomy; Theories of Moral Development- Cognitive Moral Development; Concept of moral Relativism and Moral Imperialism; Encouragement and Approaches to Ethical Behaviour.	**9**
	UNIT IV: Human Resource Policies& Procedures- Introduction, Importance of Policies, Policy Formation, Human Resources Planning. Decision-making & Ethics.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
List of Experiments:	1. Management Activities and Games 2. Case Studies 3. Group Discussion 4. Debate 5. Presentation Skit	

Course Code: HMVP 102	Allied Engineering: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	Y	N	N

Type of Course	Theory Course/ Lab Course
Course Title	**TECHNICAL COMMUNICATION**
Course Coordinator	
Course Objectives	To develop the technical communication skills among the young engineers

Course Outcomes		**Cognitive Levels**
CO1	Understand basic grammar principles and sentence construction.	Understand (Level-II)
CO2	Demonstrate clear and coherent passages and effective letters for job application.	Understand (Level-II)
CO3	Develop technical reports and interpret graphs.	Apply (Level-III)
CO4	Analyze the reading comprehension.	Analyze (Level-IV)

Semester	**1st**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	0	0	2	1	**12**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	English for Engineers and Technologists
	Author	Anna University
	Publisher	Orient Blackswan
	Edition	1st edition
2.	Title	Effective Technical Communication.
	Author	Ashraf, M Rizvi.
	Publisher	Tata McGraw-Hill
	Edition	2006

Reference Books

1.	Title	Technical Communication: Principles and Practice
	Author	Meenakshi Raman and Sangeetha Sharma
	Publisher	Oxford University Press
	Edition	2nd Edition, 2011

Course Contents	**UNIT I:**	
	Grammar Principles (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms): Idioms and Phrasal verbs--patterns of use and suggestions for effective employment in varied contexts. Effective Sentence Construction - strategies for bringing variety and clarity in	**8**

	sentences removing ambiguity - editing long sentences for brevity and clarity	
	UNIT II: Paragraph-writing: Definition of paragraph and types- features of a good paragraph- Unity of theme- coherence- linking devices- direction- patterns of development. Note-making - definition- the need for note-making - its benefits - various note formats- like tree diagram, block or list notes, tables, etc. Letter-Writing: Its importance in the context of other channels of communication- qualities of effective letters-types -personal, official, letters for various purposes- emphasis on letter of application for jobs - cover letter and resume types -examples and exercises	**8**
	UNIT III: Reading techniques: Definition- Skills and sub-skills of reading- Skimming and Scanning- their uses and purposes- examples and exercises.	**8**
	UNIT IV: Reading Comprehension - reading silently and with understanding- process of comprehension types of comprehension questions. (technical paper reading, patents) Features of Technical English - description of technical objects and process- Report- Writing definition- purpose -types- structure- formal and informal reports- stages in developing report- proposal, progress and final reports- examples and exercises.	**8**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative list of Practice:	1. English Sound System -vowels, consonants, Diphthongs, phonetic symbols- using dictionary to decode phonetic transcription-- Received Pronunciation, its value and relevance- transcription of exercises- 2. Stress and Intonation –word and sentence stress - their role and importance in spoken English 3. Intonation in spoken English -definition, patterns of intonation- –falling, rising, etc.- use of intonation in daily life-exercises 4. Introducing oneself in formal and social contexts- Role plays. - their uses in developing fluency and communication in general. 5. Oral presentation - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids. 6. Listening Comprehension -Challenges in listening, good listening traits, some standard listening tests- practice and exercises. 7. Debate/ Group Discussions-concepts, types, Do's and don'ts- intensive practice.	

SEMESTER-II

Course Code: MAVL 203	Applied Science Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**MATHEMATICS- II**			
Course Coordinator				
Course Objectives	To provide fundamental knowledge to solve linear and differential equations			

Course Outcomes		**Cognitive Levels**
CO1	Understand the mathematics fundamental necessary to formulate, solve engineering problems.	Understand (Level-II)
CO2	Apply mathematical tools for the solutions of differential equations that model physical processes.	Apply (Level-III)
CO3	Apply mathematical tools for the solutions of complex variable for differentiation.	Apply (Level-III)
CO4	Apply mathematical tools for the solutions of complex variable for integration	Apply (Level-III)

Semester	**2nd**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	1	0	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Engineering Mathematics
	Author	Reena Garg
	Publisher	Khanna Book Publishing Company
	Edition	2022
2.	Title	Advanced Engineering Mathematics
	Author	Reena Garg
	Publisher	Khanna Book Publishing Company
	Edition	2021
Reference Books		
1.	Title	Advanced Engineering Mathematics
	Author	Erwin Kreyszig
	Publisher	John Wiley & Sons
	Edition	10thEdition, 2006

Course Contents		
	UNIT I: Matrices: Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.	**9**
	UNIT II: First order ordinary differential equations: Exact, linear and Bernoulli's	**9**

	equations. Equations not of first degree: equations solvable for p, equations Solvable for y, equations solvable for x and Clairaut's type. Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.	
	UNIT III: Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	**9**
	UNIT IV: Complex Variable – Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PHVB 204	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**ENGINEERING PHYSICS**			
Course Coordinator				
Course Objectives	To provide fundamental knowledge of classical physics and quantum mechanics			

Course Outcomes		**Cognitive Levels**
CO1	To understand the concepts of Electrostatics in vacuum and dielectric medium.	Understand (Level-II)
CO2	Analyze the magneto static in linear magnetic medium.	Analyze (Level-IV)
CO3	Apply the Faraday's law and Maxwell's equation in integral and differential forms.	Apply (Level-III)
CO4	To understand the concepts of semiconductor physics.	Understand (Level-II)

Semester	**2nd**	**Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Introduction to Electrodynamics
	Author	D. J. Griffiths
	Publisher	Addison Wesley
	Edition	3rd ed. (1999)
2.	Title	Physics
	Author	Halliday and Resnick
	Publisher	John Wiely
	Edition	6th edition 2006
3.	Title	Principles of Electronic Materials and Devices
	Author	S. O. Kasap
	Publisher	Tata-McGraw Hill
	Edition	4th edition 2017
Reference Books		
1.	Title	Electricity, magnetism and light
	Author	W. Saslow
	Publisher	Academic press
	Edition	2002

Course Contents	**UNIT I:** **Electrostatics in vacuum:** Electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Boundary conditions of electric	**12**

	field and electrostatic potential; Energy of a charge distribution and its expression in terms of electric field. **Electrostatics in a linear dielectric medium:** Electrostatic field and potential of a dipole; Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in the presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.	
	UNIT II: **Magnetostatics:** Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities. **Magnetostatics in a linear magnetic medium:** Magnetization and associated bound currents; auxiliary magnetic field H; Boundary conditions on B and H. Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in the presence of magnetic materials.	**08**
	UNIT III: **Faraday's law:** Faraday's law in terms of EMF produced by changing magnetic flux; Lenz's law; Differential form of Faraday's law and calculating electric field due to changing magnetic fields in quasi-static approximation; Energy stored in a magnetic field; Magnetic field due to time-dependent electric field and Maxwell's equations: Continuity equation for current densities; Displacement current and magnetic field arising from time-dependent electric field; Calculating magnetic field due to changing electric fields in quasistatic approximation; Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Pointing vector with examples.	**08**
	UNIT IV **Semiconductor physics:** Introduction to semiconductors; Energy bands; Quantum theory and fundamentals of band structure; Fermi-Dirac distribution; Density of states; Doping and intrinsic carrier concentration; Equilibrium carrier concentration; Temperature-dependence of carrier concentration; High doping effects; Carrier scattering and mobility; Introduction to diffusion; Drift-diffusion and trap statistics; basics of semiconductor opto-electronics	**08**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments-	Experiments on electromagnetic induction and electromagnetic braking LC circuit and LCR circuit Determination of semiconductor bandgap Determination of Planck's constant using LED Basic experiments with PN junction diode, Zener diode, and LED Resonance phenomena in LCR series and parallel circuits Magnetic field from Helmholtz coil Measurement of Lorentz force in a vacuum tube	

Course Code: CSVB 204	Allied Engineering Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**PROBLEM-SOLVING AND COMPUTER PROGRAMMING**			
Course Coordinator				
Course Objectives	To give the fundamental knowledge of computer architecture and interaction between the system			

Course Outcomes		**Cognitive Levels**
CO1	Understand computer systems hardware organization and the programmer interface with the goal of improving students' abilities to reason about the execution of their programs,	Understand (Level II)
CO2	Apply to write system software, and enhance the performance of the programs they write.	Apply (Level III)
CO3	Analyze the basis for other systems courses, such Operating Systems, Computer Networks or Computer Systems Organization.	Analyze (Level IV)
CO4	Build the programming ability by teaching the basic concepts underlying all computer systems.	Evaluate (Level V)

Semester	**2nd**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Computer Systems: A Programmer's Perspective
	Author	Bryant and O'Halloran
	Publisher	Pearson
	Edition	3rd
2.	Title	Advanced Programming in the Unix Environment
	Author	Richard Stevens
	Publisher	Addison-Wesley
	Edition	1992
Reference Books		
1.	Title	Problem Solving & Programming Concepts
	Author	Maureen Sprankle, Jim Hubbard
	Publisher	Pearson
	Edition	9th edition 2011

Course Contents		
	UNIT I: Introduction to evolution of computers, computational Physics, transistors, photolithography, Moore's Law, bits, bytes, and logic, Introduction to CPU, Programming Languages.	**9**
	UNIT II: Program Structure and Execution: Representing and manipulating information: information storage, integer representations, integer Arithmetic and floating points Machine- level representation of programs: A historical	**9**

	perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control flow, procedures, array allocation and access, heterogeneous data structures. Processor Architecture: microarchitecture, X-86-64 Extending IA32 to 64 bits, instruction set architecture, logical design and hardware control language HCL, implementations Program Optimization: Capabilities of operating compilers, expressing program performance, eliminating loop inefficiencies, reducing procedure calls, memory performance Memory Hierarchy: Storage technologies, locality, memory hierarchy, cache memories, impact of caches on program performance.	
	UNIT III: Linking: Compiler Drives, Static linking, object files, relocatable object files, symbols and symbol tables, symbol resolution, relocation, executable object files, loading executable object field, dynamic linking with shared libraries. Exceptional Control flow: Exceptions, process, system call error handling, process control, signals. Virtual memory: Physical and virtual addressing, addressing space, VM as a tool for caching, memory management, address translation, memory mapping, dynamic memory allocation, garbage collection, common memory related bugs.	**9**
	UNIT IV: Interaction and communication between programs: System-level input output: Introduction to operating systems, types, Unix I/O, opening and closing files, reading and writing files, reading file metadata, sharing files, I/O redirection, standard I/O, Networking Programming: Client server programming model, Networks, Global IP Internet, Sockets Interface, Web servers, Concurrency, Distributed Systems. Introduction to AI, Security needs, Management Information System, Cloud and Quantum Computing etc.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: MAVL 205	Applied Science Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N

Type of Course	Theory Course/ Lab Course
Course Title	**PROBABILITY THEORY AND STOCHASTIC PROCESSES**
Course Coordinator	
Course Objectives	To provide the fundamentals and knowledge of random process and random signals for linear time invariant systems

Course Outcomes		**Cognitive Levels**
CO1	Understand representation of random signals	Understand (Level II)
CO2	Examine the characteristics of random processes	Apply (Level III)
CO3	Make use of theorems related to random signals	Analyze (Level IV)
CO4	To Assess the propagation of random signals in LTI systems.	Evaluate (Level V)

Semester	**3rd**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Probability and Random Processes with Applications to Signal Processing
	Author	H. Stark and J. Woods
	Publisher	Pearson Education
	Edition	Third Edition
2.	Title	Probability, Random Variables and Stochastic Processes
	Author	A.Papoulis and S. Unnikrishnan Pillai
	Publisher	McGraw Hill
	Edition	Fourth Edition

Reference Books		
1.	Title	Introduction to Probability Theory with Stochastic Processes
	Author	K. L. Chung
	Publisher	Springer International
	Edition	2012

Course Contents		
	UNIT I: Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.	**9**
	UNIT II: Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function,	**9**

	example distributions	
	UNIT III: Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds;	**9**
	UNIT IV: Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem. Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECVL 201	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course/ Lab Course
Course Title	**BASICS OF SEMICONDUCTOR MATERIALS**
Course Coordinator	
Course Objectives	To give fundamental knowledge of electrical circuits and p-n junction devices

Course Outcomes		**Cognitive Levels**
CO1	To understand the formation and properties of semiconductor crystals.	Understand (Level II)
CO2	To associate the electronic band structure to the properties of semiconductor materials and devices.	Apply (Level III)
CO3	To analyze carrier dynamics and transport in semiconductors	Analyze (Level IV)
CO4	To construct energy band diagrams of semiconductor hetero-structures	Evaluate (Level V)

Semester	2nd	Autumn

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
	3	**1**	**0**	**4**	**36**

Prerequisite course codes with course names	Engineering Physics (BSB 102)
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	The Materials Science of Semiconductors
	Author	Angus Rockett, University of Illinois, Urbana, IL, USA
	Publisher	Springer Science, Business Media, LLC
	Edition	1st Ed., 2008. [ISBN 978-0-387-25653-5]
2.	Title	Quantum Physics of Semiconductor Materials and Devices
	Author	Debdeep Jena
	Publisher	Oxford University Press, UK.
	Edition	1st Edition, May 2022. [ISBN: 9780198856856]

Reference Books		
1.	Title	Engineering Materials
	Author	Kenneth G. Budinski
	Publisher	Prentice Hall of India, New Delhi
	Edition	9th Edition, March 2009. [ISBN: 0137128428]

Course Contents		
	UNIT I: Physics of Solids: Electronic band structures of solids, Intrinsic and extrinsic semiconductors, Properties and the band structure, Quantum wells and confined carriers in nano structures, Basic quantum mechanics and solid-state physics pertinent to modern (opto)electronic technologies.	**9**
	UNIT II: Overview Of Electronic Devices: energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation,	**9**

	hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials, pn junction diodes, Schottky barriers and ohmic contacts, Semiconductor heterojunctions, Bipolar junction Transistors, Metal-Oxide-Semiconductor Filed Effect Transistors, Light Emitting Diodes, LASER diodes, Solar Cells, Photodiodes.	
	UNIT III: Aspects of Materials Science: Structures of materials, Crystal lattices, Basic thermodynamics of materials, Linking atomic orbitals to bands, Common semiconductor energy bands, Pressure and temperature dependence, Gunn diodes.	**9**
	UNIT IV: Semiconductor Alloys: Alloy selection, Semiconductor alloy thermodynamics, Band gap bowing, Silicon-germanium alloys, Metastable semiconductor alloys, Applications in Heterojunction bipolar transistors, Group IV semiconductors, Group III-V semiconductors. Defects in semiconductors, Growth Processes: Thin Film growth processes, physical vapour deposition, chemical vapour deposition etc.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code	**:**	**HSPB 151**				
Course Title	**:**	**HOLISTIC HEALTH & SPORTS**				
Type of Course	**:**	**Practical**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		0	0	2	1	28 (P)
Pre-requisite	**:**	Nil				
Physical activities, Sports, Yoga, meditation, Indore and outdoor games, etc.						

SEMESTER-III

Course Code: ECVB 302	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**PC Course: (Y/N)**	**PE Course: (Y/N)**
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**ELECTRONIC DEVICES AND CIRCUITS**			
Course Coordinator				
Course Objectives	To give insights into Electronics devices, BJT and MOS transistors and their applications and introductions to operational amplifiers and their applications.			

Course Outcomes		**Cognitive Levels**
CO1	To acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field-effect Transistors.	Remember (Level-I)
CO2	Understand the concept of BJT and MOS transistors and their characteristics.	Remember (Level-I)
CO3	Analysis and applications of BJT and MOS transistors.	Apply (Level-III)
CO4	Understand the concept of BJT and MOS transistors and their characteristics.	Analyze (Level-IV)

Semester	**3rd**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

Text Books		
1.	Title	Electronic Devices and Circuits
	Author	David A. Bell
	Publisher	Oxford
	Edition	5th
2.	Title	Microelectronic Circuits
	Author	Adel S. Sedra & Kenneth C. Smith
	Publisher	Oxford
	Edition	7th
Reference Books		
1.	Title	Physics of Semiconductor Devices
	Author	S. M. Sze and K. N. Kwok
	Publisher	John Wiley & Sons
	Edition	3rdedition, 2006
2.	Title	Solid State Electronic Devices
	Author	G. Streetman, and S. K. Banerjee
	Publisher	Pearson
	Edition	7th edition, 2014.
3.	Title	Semiconductor Physics and Devices
	Author	D. Neamen , D. Biswas
	Publisher	McGraw-Hill Education

	Edition	2017	
4.	Title	Analysis and Design of Analog Integrated Circuits	
	Author	Paul Gray, Hurst, Lewis, Meyer	
	Publisher	John Willey & Sons	
	Edition	4th	
5.	Title	Electronic Devices and Circuits	
	Author	F. Bogart Jr.	
	Publisher	Pearson	
	Edition	6th	
Course Contents	**UNIT I: Electronic Devices** PN junction, current equations, Diffusion and drift current densities, V-I characteristics, Forward and Reverse characteristics, NPN –PNP -Junctions-Early effect – Current equations – Input and Output characteristics of CE, CB CC-Hybrid pi model -h-parameter model ––Eber Moll Model, JFETs – Drain and Transfer characteristics, current equations-pinch off voltage and its significance MOSFET- characteristic-DMOSFET, EMOSFET, current equation-model parameters, threshold voltage modifications by ion implantation-channel length modulation.		**9**
	UNIT II: Amplifiers DC Load line, operating point, various biasing methods for BJT – Design-Stability-Bias compensation, Thermal stability, Design of biasing for MOSFET, Small signal analysis of common emitter – AC Loadline, Voltage swing limitations, Common collector and common base amplifiers, Differential amplifier – CMRR, Darlington amplifier – Bootstrap techniques – Cascaded stages – Cascode Amplifier, Small signal analysis of Common source, source follower and Common Gate amplifiers, CMOS Inverters – DC analysis of CMOS inverter – Voltage Transfer Curve – Noise Margin – VTC.		**9**
	UNIT III: Oscillators and Multivibrators Barkhausen criteria for oscillator – Analysis of RC oscillators – Phase shift, Wein bridge oscillators – LC oscillators – Colpitt, Hartely, Clapp, Crystal, Armstrong, Franklin and Ring oscillators, Switching characteristics of transistors – Astable, Monostable and Bistable multivibrators, Schmitt trigger.		**9**
	UNIT IV: Operational Amplifier The basic operational amplifier and its characteristics, Block diagram representation of Operational amplifier, Inverting Amplifier, Non-Inverting Amplifier, Basic Application of Operation Amplifier: Subtractor, Summing Amplifier, Integrator, Differentiator, Digital to Analogue Convertor, Active filters - first order and second order filters.		**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course Code: ECVB 303	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**SIGNALS AND SYSTEMS**			
Course Coordinator				
Course Objectives	To provide the knowledge of different types of signal and systems and their transform and response analysis			

Course Outcomes		**Cognitive Levels**
CO1	Understand the continuous and discrete-time signals and systems, their properties and representations and	Understand (Level-II)
CO2	Analyze methods those are necessary for the analysis of continuous and discrete-time signals and systems.	Analyze (Level-IV)
CO3	Apply the Knowledge of time-domain representation and analysis concepts as they relate to difference equations, impulse response and convolution, etc.	Apply (Level-III)
CO4	Apply the Knowledge of frequency-domain representation and analysis concepts using Fourier Analysis tools, Z-transform.	Apply (Level-III)

Semester	**3rd**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Signals and Systems
	Author	Alan V. Oppenheim, Alan S. Willsky with S. Hamid Nawab
	Publisher	PHI Publications
	Edition	2011
2.	Title	Principles of Linear Systems and Signals
	Author	B.P. Lathi
	Publisher	Oxford University Press Publications
	Edition	2013

Reference Books

1.	Title	Signals and Systems
	Author	Simon Haykin
	Publisher	John Wiley and Sons Publications
	Edition	2009

Course Contents	**UNIT I:** Continuous and discrete time signals: Classification of Signals – Periodic aperiodic even – odd – energy and power signals – Deterministic and random signals – complex exponential and sinusoidal signals – periodicity – properties of discrete time complex exponential unit impulse – unit step impulse functions – Transformation in independent variable of signals: time scaling, time shifting. Determination of Fourier series representation of continuous	**9**

	time and discrete time periodic signals – Explanation of properties of continuous time and discrete time Fourier series. Representation of continuous time signals by its sample - Sampling theorem – Reconstruction of a Signal from its samples, aliasing – discrete time processing of continuous time signals, sampling of band pass signals.	
	UNIT II: Continuous time Fourier Transform and Laplace Transform analysis with examples – properties of the Continuous-time Fourier Transform and Laplace Transform basic properties, Parseval's relation, and convolution in time and frequency domains. Basic properties of continuous time systems: Linearity, Causality, time invariance, stability, magnitude and Phase representations of frequency response of LTI systems -Analysis and characterization of LTI systems using Differential Equations and Continuous time LTI systems. Laplace transform: Computation of impulse response and transfer function using Laplace transform.	**9**
	UNIT III: Discrete time system analysis using Difference equations, Discrete Time Fourier Transform, Discrete Fourier Transform, FFT and their property and usage in the analysis of Discrete time systems	**9**
	UNIT IV: Basic principles of z-transform - z-transform definition – region of convergence – properties of ROC – Properties of z-transform – Poles and Zeros – inverse z-transform using Contour integration - Residue Theorem, Power Series expansion and Partial fraction expansion, Relationship between z-transform and Fourier transform. Properties of convolution and the interconnection of LTI Systems – Causality and stability of LTI Systems. Computation of Impulse & response & Transfer function using Z Transform.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments:	1. MATLAB Basics, Independent and dependent variable and function generation 2. Signal Generation: Such as unit impulse, unit step, Sinusoidal, exponential and others. 3. To create user function for performing signal operations: folding, Shifting, scaling, addition for continuous and discrete time signal. 4. Convolution and its properties for continuous and discrete time signal. 5. Implementation of Continuous Time Fourier Series (CTFS) of continuous periodic time signals. 6. Properties of CTFS and implementation of Discrete Time Fourier Series (DTFS) of Discrete periodic time signals. 7. Properties of DTFS. 8. Implementation of Discrete Time Fourier Transform (DTFT) of discrete time aperiodic signals. 9. Properties of DTFT. 10. Implementation of Discrete Fourier Transform (DFT) of discrete time signals.	

Course Code: ECVB 304	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**DIGITAL ELECTRONICS**			
Course Coordinator				
Course Objectives	To provide fundamentals of digital logics, digital operations and combinational and sequential logics			

Course Outcomes		**Cognitive Levels**
CO1	Understand digital logic levels and application of knowledge to understand digital electronics circuits.	Understand (Level-II)
CO2	Understand the concept of digital and binary systems	Understand (Level-II)
CO3	Design and analyze combinational logic circuits.	Create (Level-VI)
CO4	Design and analyze sequential logic circuits.	Create (Level-VI)

Semester	**3rd**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Digital Design, Principles and Practices
	Author	J. F. Wakerly
	Publisher	Pearson Education
	Edition	4th, 2005
2.	Title	Digital Computer Fundamentals
	Author	T.C. Bratee
	Publisher	McGraw Hill.
	Edition	2001
Reference Books		
1.	Title	Digital Logic & Computer Design
	Author	M Morris Mano
	Publisher	Pearson
	Edition	5th, 2011

Course Contents	**UNIT I:** **Fundamentals of Digital Systems:** Analog and Digital signals, digital circuits, Logic gates, Examples of IC gates, Boolean Algebra. Standard representation for logic functions, K-map representation, and simplification of logic functions using K-map, Don't care conditions, XOR and XNOR simplification of K-maps, minimization of logic functions using Quine-McCluskey's algorithm.	**9**

	UNIT II: **Combinational Digital Circuits:** Multiplexer, De-Multiplexer, Decoders, Encoder, Binary Adders and Subtractors, Binary multiplier, Binary parallel adder - Carry lookahead adder, BCD Adder, Magnitude Comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Mux/Demux, Case study: Digital trans-receiver, 8-bit arithmetic and logic unit.	**9**
	UNIT III: **Sequential circuits and systems:** S-R, J- K, T and D flip flops, race around condition, Level and Edge triggering mechanism, Master-slave flip flop, Excitation and characteristics tables of flip-flops, realization of flip-flops using other flip-flops, shift registers, applications of shift registers, Ripple (Asynchronous) counters, Synchronous counters, design of counters, special counter IC's: Ring counter and Johnson counter. Mealy and Moore machine, state diagram, state table, Design of sequence detector.	**9**
	UNIT IV: **Logic families:** Characteristics of Digital ICs, Digital logic families: TTL, ECL and CMOS logic. Semiconductor memories and Programmable logic devices: Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM), content addressable memory (CAM). ROM as a PLD, Programmable logic array (PLA), Programmable array logic (PAL), Field Programmable Gate Array (FPGA).	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments	• Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates • Construction of half and full adder using XOR and NAND gates and verification of its operation. • To Study and Verify Half and Full Subtractor • Realization of logic functions with the help of Universal Gates (NAND, NOR) • Construction of a NOR gate latch and verification of its operation • Verify the truth table of RS, JK, T and D flip-flops using NAND and NOR gates • Design and verify the 4-Bit Serial In - Parallel Out Shift Registers • Implementation and verification of decoder and encoder using logic gates • Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates • Design and verify the 4- Bit Synchronous or Asynchronous Counter using JK Flip Flop • Verify Binary to Gray and Gray to Binary conversion using NAND gates only • Verify the truth table of one bit and two-bit comparator using logic Gates.	

Course Code: EEVL 305	Allied Engineering Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course			
Course Title	**NETWORK ANALYSIS AND CONTROL THEORY**			
Course Coordinator				
Course Objectives	To equip students with foundational and advanced knowledge of network analysis and control theory for modeling, analyzing, and designing stable and efficient engineering systems.			

Course Outcomes		**Cognitive Levels**
CO1	Apply the knowledge of basic circuital law and simplify the circuit networks.	Apply (Level-III)
CO2	Analyze the fundamentals of network analysis using matrices, two-port, and network synthesis.	Analyze (Level-IV)
CO3	To understand the concept of open loop and closed loop control systems.	Analyze (Level-IV)
CO4	Study time domain analysis and different methods of stability analysis.	Evaluate (Level-V)

Semester	**3rd**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	1	0	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Network Analysis
	Author	M.E. Van Valkenburg
	Publisher	Prentice Hall
	Edition	3rd Ed.
2.	Title	Network Analysis and Synthesis
	Author	Franklin F. Kuo
	Publisher	Wiley
	Edition	2nd Ed.
3	Title	Control Systems Engineering
	Author	I. J. Nagrath and M. Gopal,
	Publisher	New Age International (P) Limited, Publishers
4	Title	Solutions and Problems of Control Systems
	Author	A.K. Jairath
	Publisher	CBS Publishers
Reference Books		
1.	Title	Engineering Circuit Analysis
	Author	W. H. Hayt and J E Kemmerly
	Publisher	TMH

	Edition	8th Ed.	
2	Title	Control Systems: Theory and Applications,	
	Author	Smarajit Ghosh	
	Publisher	Pearson.	
	Edition	2/e	
Course Contents	**UNIT I:** Circuits: Voltage, Ideal Voltage Source, Current Ideal Current Sources, Ohm's Law, Resistively, Temperature Effect, Resistors, Resistor Power Absorption, Colour Codes, Internal Resistance. Capacitance, Inductance, Transformers, Fourier series, Fourier transform, Laplace transform, and analysis of differential equations with constant coefficients DC Circuits: Series and Parallel Circuits, Mesh Analysis, Loop Analysis, Nodal Analysis, Thevenin's and Norton's Theorem, Maximum Power Transfer Theorem, Superposition Theorem, Millman's Theorem, Tellegen's Theorem, Y - Δ and Δ- Y Transformation, Bridge Circuits.		**9**
	UNIT II: AC Circuits: Circuits containing Capacitors and Inductors, Transient Response, Alternating Current and Voltages, Phasors, Impedances and Admittance, Y - Δ and Δ- Y Transformation, Bridge Circuits. Resonant Circuits. Two port Networks. Relationship between two port parameters, transmission parameters, hybrid parameters, interconnections of two port, analysis of ladder networks, Passive Filters. Positive Real Function: Driving-Point Functions, Properties of Positive Real Functions. Properties of Hurwitz Polynomials.		**9**
	UNIT III: Introduction: Classification of control systems - Open loop and closed loop control systems, feedback effects, Transfer Function Representation: Block diagram algebra, Signal flow graphs (SFG) - Reduction using Mason's gain formula. Time Response Analysis: Standard test signals, Time response of first order systems, Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications, Steady state response, Steady state errors and error constants.		**9**
	UNIT IV: The concept of stability: Routh-Hurwitz's stability criterion, Limitations of Routh-Hurwitz's stability. Root Locus Technique: Concept of root locus - Construction of root locus, Frequency Response Analysis: Introduction, Frequency domain specifications, Bode plot diagrams: Determination of Phase margin and Gain margin, Stability analysis from Bode plots, Polar plots.		**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course Code: CSVB 306	Allied Engineering Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course and Lab			
Course Title	**DATA STRUCTURE AND PROGRAMMING**			
Course Coordinator				
Course Objectives	This course aims to provide students with a foundation in computer programming. The goals of the course are to develop the basic programming skills in students, and to improve their proficiency in applying the basic knowledge of programming to solve problems related to their field of engineering.			

Course Outcomes		**Cognitive Levels**
CO1	Recognize the need of different data structures and understand their characteristics.	Understand (Level-II)
CO2	Demonstrate the operations for maintaining common data structures and recognize the associated algorithms' complexity.	Understand (Level-II)
CO3	Apply different data structures including stacks, queues, hash tables, binary and general tree structures, search trees, and graphs for given problems.	Apply (Level-III)
CO4	Design, analyse and compare different algorithms for sorting and searching techniques.	Evaluate (Level-V)

Semester	**3rd**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	An Introduction to Data Structures with Applications
	Author	Trembley & Sorenson
	Publisher	TMH
	Edition	2/E, 1991
2.	Title	Data Structures using C and C++
	Author	Tanenbaum & Augenstein
	Publisher	Pearson
	Edition	2/E, 2007
3.	Title	The C PROGRAMMING LANGUAGE
	Author	B.W. Kernighan & D.M. Richie
	Publisher	Prentice Hall
	Edition	2/E, 1988
Reference Books		
1.	Title	Fundamentals of Data Structures
	Author	E. Horowitz and S. Sahni
	Publisher	Computer Science Press

	Edition	2nd Edition, 2008	
2.	Title	Let Us C	
	Author	Y. Kanetkar	
	Publisher	Infinity Science Press	
	Edition	13th Edition, 2012	
Course Contents	**UNIT I: INTRODUCTION TO COMPUTER PROGRAMMING AND DATA STRUCTURES** Introduction to programming language, Basics of C, Basic Data types – int, float, double, char, Bool, Void. Arithmetic and logical operators: precedence and associativity. Flow of Control- Conditional statements- If-else, Switch-case constructs, Loops- While, do-while, for. Definition, Characteristics, Creation and manipulation of data structures, Operations on data structures, Types of data structures. Introduction to algorithms, Asymptotic notations, Analysis of algorithms, Time and Space complexity.		**08**
	UNIT II: ARRAY AND LINKED LISTS Arrays, Dynamic memory allocation, one-dimensional array, multi-dimensional array, types of arrays, operations on arrays, row major representation, column major representation, Searching Methods, Linear Search, Binary Search. LINEAR LISTS, Sequential and Linked Representations of Linear Lists, Comparison of Insertion, Deletion and Search Operations for Sequential and Linked Lists, Doubly Linked Lists, Circular Lists, Applications of Lists.		**08**
	UNIT III: STACKS AND QUEUES STACKS: Sequential and Linked Implementations, Representative Applications such as Recursion: Tail Recursion, non-tail recursion, nested recursion, indirect recursion, Expression Evaluation Viz., Infix, Prefix and Postfix, Parenthesis Matching, Towers of Hanoi. QUEUES: Implementation of Queues-array and linked list, Operations of Queues, Circular Queue, Priority Queue, Dequeue, Applications of Queues.		**08**
	UNIT IV: GRAPHS AND TREES GRAPHS: Definition, Terminology, Directed and Undirected Graphs, Properties, Connectivity in Graphs, Applications, Adjacency Matrix and Linked Adjacency Chains, Graph Traversal, Breadth First and Depth First Traversal, Spanning Trees, Shortest Path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths. TREES: Binary Trees and Their Properties, Terminology, Sequential and Linked Implementations, Tree Traversal Methods and Algorithms, Complete Binary Trees, General Trees, Binary Search Trees, AVL Trees, Threaded Trees, Heaps, Heap Implementation, Insertion and Deletion Operations, Heapsort. MULTIWAY TREES: M-Way Search Trees, B Trees, Search, Insert and Delete Operations, Height of B-Tree, 2-3 Trees.		**08**
	UNIT V: SORTING		**08**

	SORTING: Sorting Methods, Bubble Sort, Selection Sort, Quick Sort, Radix Sort, Bucket Sort, Dictionaries, Hashing, Analysis of Collision Resolution Techniques, Character Strings and Different String Operations. Algorithm design techniques: Greedy programming, Dynamic programming	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments	To be displayed at the beginning of the semester by the concerned course In-Charge. ● Introduction to Programming Logic Building ● Basic Concepts of a Computer Programming Language ● Implementation of sequential constructs ● Implementation of selection constructs ● Implementation of Iterative constructs ● Implementation of functions (normal functions, recursive functions and parameter passing methods) ● Implementation of Array and its applications ● Implementation of Stack and its applications ● Implementation of Queue and its applications ● Implementation of Link List and its applications ● Implementation of Trees and its applications ● Implementation of Graph and its applications	

Course Code: ECVB 405	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**PC Course: (Y/N)**	**PE Course: (Y/N)**
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**MICRO FABRICATION TECHNOLOGY**			
Course Coordinator				
Course Objectives	To provide the fundamental knowledge of fabrication methods of CMOS integrated circuit designs and scaling technology			

Course Outcomes		**Cognitive Levels**
CO1	Understand the CMOS process flow	Understand (Level-II)
CO2	Identify various critical processing steps in microfabrication	Apply (Level-III)
CO3	Apply the advanced methods involved in IC fabrication.	Apply (Level-III)
CO4	Analyze the advancements in CMOS process fabrication with scaling in technology.	Analyze (Level-IV)

Semester	**5th**	**Autumn**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Silicon VLSI Technology
	Author	Plummer, Deal and Griffin
	Publisher	Pearson Education
	Edition	1st Edition, 2009
2.	Title	Fundamental of Semiconductor Fabrication
	Author	Sze and May
	Publisher	Wiley India
	Edition	2nd Edition, 2009
Reference Books		
1.	Title	Silicon Process Technology
	Author	S K Gandhi
	Publisher	Wiley India
	Edition	2nd Edition, 2009

Course Contents		
	UNIT I: Introduction: History of IC's; Operation & Models for Devices of Interest: CMOS and MEMS. Electronic Materials: Crystal Structures, Defects in Crystals, Si, Poly Si, Si Crystal Growth. Clean room and Wafer Cleaning: Definition, Need of Clean Room, RCA cleaning of Si.	**9**
	UNIT II: Oxidation: Dry and Wet Oxidation, Kinetics of Oxidation, Oxidation Rate	**9**

	Constants, Dopant Redistribution, Oxide Charges, Device Isolation, LOCOS, Oxidation System Lithography: Overview of Lithography, Radiation Sources, Masks, Photoresist, Components of Photoresist Optical Aligners, Resolution, Depth of Focus, Advanced Lithography: E-beam Lithography, X-ray Lithography, Ion Beam Lithography.	
	UNIT III: Diffusion: Pre-Deposition and Drive-in Diffusion Modelling, Dose, 2-Step Diffusions, Successive Diffusion, Lateral Diffusion, Series Resistance, Junction Depth, Irvin's Curves, Diffusion System. Ion Implantation: Problems in Thermal Diffusion, Advantages of Ion Implantation, Applications in ICs, Ion Implantation System, Mask, Energy Loss Mechanisms, Depth Profile, Range & Straggle, Lateral Straggle, Dose, Junction Depth, Ion Implantation Damage, Post Implantation Annealing, Ion Channelling, Multi Energy Implantation	**9**
	UNIT IV: Thin Film Deposition: Physical Vapor Deposition: Thermal evaporation, Resistive Evaporation, Electron beam evaporation, Laser ablation, Sputtering Chemical Vapor Deposition: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, Boundaries and Flow, Different kinds of CVD techniques: APCVD, LPCVD, Metalorganic CVD(MOCVD), Plasma Enhanced CVD etc. Etching: Anisotropy, Selectivity, Wet Etching, Plasma Etching, Reactive Ion Etching. Overview of Interconnects, Contacts, Metal gate/Poly Gate, Metallization.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments	• Learn the techniques of Micro fabrication (Process simulator) • Etching process • Printing process • Metallization	

Course Code: ECVB 406	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**DIGITAL SYSTEM DESIGN**			
Course Coordinator				
Course Objectives	To give the fundamental knowledge of digital combinational and sequential circuits with the help of HDL and EDA tool			

Course Outcomes		**Cognitive Levels**
CO1	Design, analysis and optimization of synchronous circuits.	Analyze (Level-IV)
CO2	Design, analysis and optimization of asynchronous circuits	Analyze (Level-IV)
CO3	To get exposure to FPGA architecture and Verilog HDL	Analyze (Level-IV)
CO4	Use HDL and appropriate EDA tools for digital logic design and simulation	Apply (Level-III)

Semester	**4th**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Digital Design with an introduction to HDL, VHDL and Verilog
	Author	M. Morris Mano and Michel. D. Ciletti
	Publisher	Pearson education
	Edition	Sixth edition
2.	Title	Fundamentals of Logic Design
	Author	Charles H. Roth Jr
	Publisher	Thomson Learning
	Edition	2004
3.	Title	Advanced FPGA Design: Architecture, Implementation, and Optimization
	Author	Steve Kilts
	Publisher	Wiley
	Edition	2007
Reference Books		
1.	Title	Advanced Digital Logic Design: Using VHDL, State Machine, and Synthesis for FPGAs
	Author	Sunggu Lee

	Publisher	Nelson Engineering	
	Edition	2005	
2.	Title	Verilog HDL	
	Author	Samir Palnitkar	
	Publisher	Pearson	
	Edition	2nd Edition 2003	
Course Contents	**UNIT I: Sequential Circuit Design** Analysis of clocked synchronous sequential circuits and modelling – State diagram, state table, state table assignment and reduction – Design of synchronous sequential circuit design of iterative circuits – ASM chart and realization using ASM.		**9**
	UNIT II: Asynchronous Sequential Circuit Design Analysis of asynchronous sequential circuit – flow table reduction – race -state assignment – transition table and problem in transition table – design of asynchronous sequential circuit – Static, dynamic and essential hazards – data synchronizers – mixed operating mode asynchronous circuits – designing electronic voting machine, vending machine controller.		**9**
	UNIT III: Introduction to Verilog HDL Logic design with Verilog: Introduction to Verilog, logic design with structural, behavioural and data flow models of combinational and sequential logic, synthesis of combinational, sequential logic and state machine, Design and synthesis of data path controllers, programmable logic and storage devices, algorithms and architectures for digital processors, architectures for arithmetic processors, Case study: FIFO, Traffic signal controller, newspaper vending machine.		**9**
	UNIT IV: Designing with FPGAs Overview, programming technologies, configurable logic block, FPGA routing architectures, Design flow for FPGAs, prototyping with FPGAs, and debugging. (Utilize commercial FPGA development tools for compilation, simulation, synthesis, implementation, and debugging), Case studies of FPGA applications – System on a programmable chip (SoPC) Design.		**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course Code: ECVB 407	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**ANALOG COMMUNICATION**			
Course Coordinator				
Course Objectives	To provide fundamental knowledge of analog modulation and demodulation techniques, Transmitter and receiver circuits and pulse modulation techniques			

Course Outcomes		**Cognitive Levels**
CO1	Understand the basic concepts of Amplitude Modulation, Frequency modulation, Phase modulation techniques.	Understand (Level-II)
CO2	Analyze different analog communication modulation techniques	Analyze (Level-IV)
CO3	Understand the concept of radio receivers	Understand (Level-II)
CO4	Analyze the pulse modulation techniques	Analyze (Level-IV)

Semester	**4th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Electronic Communication Systems
	Author	Kennedy, Davis
	Publisher	McGraw Hill
	Edition	4/e, 1999
2.	Title	Communication Systems
	Author	S. Haykins
	Publisher	Wiley
	Edition	4/e, 2001
Reference Books		
1.	Title	Introduction to Communication Systems
	Author	B. Carlson
	Publisher	McGraw-Hill
	Edition	4/e, 2009

Course Contents	**UNIT I:** Introduction: Introduction to communication systems, guided and unguided transmission media, concept of bandwidth, electromagnetic spectrum and its usage, Review of Signal representation using Fourier Series & Fourier Transform. Introduction to Noise: Atmospheric, Thermal, Shot and Partition noise, Noise figure and experimental determination of noise figure, Shot noise	**9**

	in temperature limited diode and space charge limited diodes, Pulse response and Digital noise.	
	UNIT II: Analog Modulation Techniques: Introduction and need of modulation, Theory of Amplitude Modulation; Amplitude modulation, DSB, SSB, (with and without carrier), VSB, Power Calculations, Generation of AM. Theory of Frequency Modulation (FM); FM and PM, Transmission FM spectra, Carson 's rule, Bandwidth of FM, reactance FET modulator Armstrong method, Foster-Seely discriminator, PLL detector, Stereophonic FM, Narrow band and wide band FM. Comparison of FM and PM.	**9**
	UNIT III: Radio receivers: Tuned radio frequency receiver, Super heterodyne receiver, Sensitivity and selectivity, selection of IF. Block diagram and features of Communication Receiver and its spectral features.	**9**
	UNIT IV: Pulse Modulation Transmission and Reception: Sampling Theorem–low pass and band pass, Pulse Amplitude Modulation (PAM), Pulse Time Modulation (PTM); Pulse Width Modulation (PWM).	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments:	1. Study of AM Modulation/Demodulation. 2. Study of FM Modulation/Demodulation. 3. Study of Diode detector and AGC. 4. To study Sampling theorem. 5. Sensitivity of a super het Receiver. 6. Selectivity of a super het Receiver. 7. Fidelity of a super het Receiver. 8. Study of Pulse Amplitude Modulation/Demodulation. 9. Study of Pulse Width Modulation/Demodulation. 10. Study of Pulse Position Modulation/Demodulation.	

Course Code: ECVL 408	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course/ Lab Course
Course Title	**MICROPROCESORS AND MICROCONTROLLERS**
Course Coordinator	
Course Objectives	To gain the fundamental concept of microcontrollers and microprocessor, their instruction set, addressing mode and program for 8085, 8086 and 8051.

Course Outcomes		**Cognitive Levels**
CO1	Demonstrate the architecture of 8085, 8086, 8051and ARM and their addressing modes and instruction set.	Understand (Level-II)
CO2	Understand the need and use of Peripherals and Interfacing and develop skill to explore system design technique.	Understand (Level-II)
CO3	To understand the RISC and CISC architecture and to explore the ARM architecture.	Understand (Level-II)
CO4	Analyze microprocessor and microcontroller-based system design and impart knowledge on embedded S/W development.	Analyze (Level-IV)

Semester	**5th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Microprocessor Architecture, Programming and Applications with 8085
	Author	Ramesh S. Gaonkar
	Publisher	Penram International Publishing reprint
	Edition	6th Edition, 2017
2.	Title	Microprocessor and Interfacing, Programming and Hardware
	Author	Douglas V. Hall,
	Publisher	Tata McGraw Hill
	Edition	Revised 2nd Edition 2006, 11th reprint 2015

Reference Books		
1.	Title	The 8051 Microcontroller and Embedded Systems
	Author	Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley
	Publisher	Pearson Education
	Edition	2nd Edition,12th impression 2018

Course Contents		
	UNIT I: Introduction to 8085, 8086 Architecture, Instruction set and programming, 8086 addressing modes, 8086 Instruction formats and Instruction set descriptions and Assembler directives, 8086 interrupts and interrupt applications	**9**
	UNIT II: Programmable Peripheral Interface (8255), Keyboard display controller (8279), ADC0808 and DAC0808 Interface, Programmable Timer Controller (8254), Programmable interrupt controller (8259), Serial Communication Interface (8251).	**9**

	UNIT III: 8051 – Architecture, Special Function Registers (SFRs), Instruction set, Addressing modes, Assembly language programming, I/O Ports, Timers / counters, Interrupts and serial communication.	**9**
	UNIT IV: RISC Vs CISC Architecture, ARM Processor Architecture, ARM Core data flow model, Barrel Shifter, ARM processor modes and families, pipelining, ARM instruction Set and its Programming. Interfacing to: matrix display, (16x2) LCD, high power devices, optical motor shaft encoder, Stepper Motor, DC Motor speed Control using PWM, RTC and EEPROM interface using I2C protocol.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments:	**Assembly Language Programming of 8086:** 1. Programs for 8 / 16 bit Arithmetic, Sorting, Searching and String operations. 2. Programs for Digital clock, Interfacing ADC and DAC. 3. Interfacing and programming 8279, 8259, and 8253. 4. Serial Communication between two microprocessors kits using 8251. 5. Interfacing Stepper Motor, Speed control of DC Motor 6. Parallel communication between two microprocessors kits using Mode 1 and Mode 2 of 8255. 7. Macro assembler Programming for 8086. **8051 based experiments using assembly language and C programming:** 8. Programming using Arithmetic, Logical and Bit Manipulation instructions of the 8051 microcontrollers. 9. Programming and verifying Timer, Interrupts and UART operations in 8051 microcontrollers. 10. Interfacing – DAC and ADC and 8051 based temperature measurement 11. Interfacing – LED and LCD 12. Interfacing – Stepper motor and traffic light control system. 13. Communication between 8051 Microcontroller kit and PC. 14. Programming ARM processor using Embedded C.	

Course Code: ECVB 409	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course/ Lab Course
Course Title	**DIGITAL SIGNAL PROCESSING**
Course Coordinator	
Course Objectives	To gain the knowledge of digital filtering techniques of discrete time signals, their transform and their mathematical analysis

Course Outcomes		**Cognitive Levels**
CO1	Define discrete-time signals analytically and visualize them in the time domain.	Remember (Level-I)
CO2	Understand the meaning and implications of the properties of systems and signals.	Understand (Level-II)
CO3	Understand the Transform domain and its significance and problems related to computational complexity.	Understand (Level-II)
CO4	Assess to specify and design any digital filters using MATLAB	Evaluate (Level-V)

Semester	**4th**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Digital Signal Processing: A Computer-Based Approach
	Author	S. K. Mitra
	Publisher	McGraw-Hill
	Edition	Third edition, 2006
2.	Title	Discrete-Time Signal Processing
	Author	A. Oppenheim and R. Schafer
	Publisher	Prentice Hall
	Edition	Second edition, 1999

Reference Books		
1.	Title	Schaum's Outline of Digital Signal Processing
	Author	M. Hays
	Publisher	McGraw-Hill
	Edition	1999

Course Contents		
	UNIT I: Introduction to Digital signal processing, Overview of Typical Digital signal processing in real-world applications, Discrete time signals and sequence operations, properties. Discrete time systems, their properties, Linear time invariant systems.	**9**
	UNIT II: Z-transforms by summation of left, right, and two-sided sequences, Regions of convergence and Z-transform properties, Inverse Z-transform, Stability and causality, Solution of Difference Equations Using Z-transform.	**9**

	UNIT III: Definition of Discrete Fourier Transform (DFT) and relation to Z-transform, Properties of the DFT, Matrix Formulation of the DFT and IDFT, Linear and periodic convolution using the DFT, zero padding, spectral leakage, resolution and windowing in the DFT.	**9**
	UNIT IV: Structures and properties of FIR and IIR filters, IIR– Direct, parallel and cascaded realizations, FIR – Direct and cascaded realizations, Coefficient quantization effects in digital filters. Digital filter design, Finite impulse response (FIR) filters-Window design techniques, Kaiser Window design technique, Equi-ripple approximations, Infinite impulse response (IIR) filters-Bilinear transform method, Examples of bilinear transform method.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments:	• Study of Floating-Point Digital Signal Processor & Fixed-Point Digital Signal Processor. • Realisation of Circular & Linear Convolution and Correlation of two sequences. • Computation of DFT & IDFT of a given Sequence using DSP Processors. •Classification, denoising of real time signals. • Radix-2 & Radix-4 algorithm FFT Calculation using DSP Processors. • FIR & IIR Filter Implementation using the DSP Processors. • Basics of MATLAB-Realisation of Unit Impulse, Unit Step & Unit Ramp signals. • Linear & Circular Convolution of two Sequences, Correlation of two sequences. • DFT & IDFT Computation. • Radix-2 algorithms FFT Calculation. • Generation of Gaussian Distributed Numbers.	

Course Code	**:**	**ECVP 410**				
Course Title	**:**	**Mini Project**				
Type of Course	**:**	**Program Core**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		0	0	2	1	--
Pre-requisite	**:**	Nil				
Mini project related with the Microelectronics/VLSI/ECE.						

Course Code: ECVB 511	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**PC Course: (Y/N)**	**PE Course: (Y/N)**	
	N	N	Y	N	
Type of Course	Theory Course/ Lab Course				
Course Title	**DIGITAL COMMUNICATION**				
Course Coordinator					
Course Objectives	To provide the fundamental knowledge of digital modulation techniques and noises in the digital systems				
Course Outcomes				**Cognitive Levels**	
CO1	To understand the building blocks of digital communication system.			Understand (Level-II)	
CO2	To build up concept and analyze the signal flow in a digital communication system			Apply (Level-III)	
CO3	To analyze error performance of a digital communication system.			Analyze (Level-IV)	
CO4	To understand concept of spread spectrum communication system.			Understand (Level-II)	
Semester	**5th**		**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					
Text Books					
1.	Title	Principles of communication systems			
	Author	Taub & Schilling			
	Publisher	McGraw-Hill Education			
	Edition	4th Edition			
2.	Title	Communication systems			
	Author	Simon Haykin			
	Publisher	John-Wiley & sons, Inc.			
	Edition	4rth Edition			
Reference Books					
1.	Title	Digital and Analog Communication Systems			
	Author	Couch			
	Publisher	Pearson Education			
	Edition	6th Edition			
Course Contents	**UNIT I:** Review of probability theory and Stochastic processes, Poisson and Gaussian Process, Noise, Narrowband Noise, Sinewave plus Narrowband Noise. Information Theory: Entropy, Source Coding Theorem, Lossless data compression, Discrete Memoryless channel, Mutual Information, Channel Capacity, Channel Coding Theorem, Differential Entropy and Mutual				**9**

	Information for Continuous Random Ensembles, Information Capacity Law. Sampling Theory, PAM, Quantization characteristics, PCM, DPCM, Delta Modulation, Line Codes	
	UNIT II: AWGN Channel Signalling: Geometric Representation of Signals, Conversion of Continuous AWGN Channel to a vector channel, ASK, QASK, FSK, M-array FSK, BPSK, DPSK, DEPSK, QPSK, M-array PSK, QAM, MSK, GMSK, Coherent and non-coherent detection and other keying techniques.	**9**
	UNIT III: Band Limited Channels: Error rate due to channel noise in a matched filer receiver, Intersymbol Interference, Signal Design for Zero ISI, Ideal Nyquist Pulse for Distortionless Baseband data transmission, raised cosie and square root raised cosine spectrum, Eye pattern, Adaptive equalization, signalling over multiple baseband channel, Digital Subscriber Lines Fading Channels: Propagation effects, Jakes Model, Statistical Characteristics of wideband wireless channel, FIR modelling of doubly spread channel, Effects of flat fading, Diversity techniques, MIMO, MIMI Capacity for channel known at receiver, OFDM, Spread-spectrum signals, CDMA, Rake receiver and Multipath Diversity	**9**
	UNIT IV: Error Control Coding: Introduction, Error Control using forward correction, Discrete Memory less channel, Linear Block Code, Cyclic Codes, Convolutional Codes, Optimum Decoding of Convolutional Codes.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECVB 512	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course/ Lab Course
Course Title	**DIGITAL VLSI DESIGN**
Course Coordinator	
Course Objectives	To provide in-depth understanding of the VLSI design process and digital integrated circuits and basic idea on IC manufacturing process.

Course Outcomes		**Cognitive Levels**
CO1	Interpret the design of digital integrated circuits, MOS fundamentals and analysis of MOSFET based digital circuits.	Understand (Level-II)
CO2	Design and study the MOS inverters and combinational circuits,	Apply (Level-III)
CO3	Design the CMOS based sequential circuit, dynamic logic circuits and MOS memories.	Create (Level-VI)
CO4	To understand the VLSI design flow and design styles.	Understand (Level-II)

Semester	**5th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	CMOS Digital Integrated Circuits
	Author	Sung-Mo Kang, Yusuf Leblebici
	Publisher	Tata McGraw Hill
	Edition	2014
2.	Title	Digital Integrated Circuits: A Design Perspective
	Author	J.M Rabaey, A. Chandrakasan, B.Nikolic
	Publisher	Pearson
	Edition	2012
Reference Books		
1.	Title	Introduction to VLSI Circuits and Systems
	Author	J. P. Uyemura
	Publisher	Wiley
	Edition	2006

Course Contents		
	UNIT I: Introduction: Basic principle of MOS transistor, Introduction to large signal MOS models (long channel) for digital design. MOS Circuit Layout & Simulation and manufacturing: scaling, MOS SPICE model and simulation, CMOS layout: design rules, Transistor layout, Inverter layout, NMOS and CMOS basic manufacturing steps. CMOS latch-up and its prevention.	**9**
	UNIT II: The MOS Inverter: Inverter principle, the basic CMOS inverter, transfer	**9**

	characteristics, logic threshold, Noise margins, switching characteristics, Propagation Delay, Power Consumption. Combinational MOS Logic Design: Static MOS design, Ratioed logic, Pass Transistor logic, complex logic circuits. CMOS Transmission Gates, Complementary Pass Transistor Logic, Transistor sizing in static CMOS, logical effort, Pass-transistor logic, sizing issues.	
	UNIT III: Sequential Logic Circuits: Introduction, Static Latches and Registers, Dynamic Latches and registers, Pipelining. Timing issues in Digital Circuits: Timing classification of digital systems, Synchronous Design Timing basics, clock skew, clock jitter and their combine impact. Dynamic Logic Circuits: Voltage Bootstrapping, Synchronous Dynamic Logic, Dynamic CMOS Logic, High Performance Dynamic CMOS Circuits, Domino CMOS logic, NP-Domino Logic, Zipper CMOS Circuits, TSPC Dynamic CMOS.	**9**
	UNIT IV: VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concepts of Regularity, Modularity and Locality, VLSI Design Styles. CMOS Sub system design: Adders, Multipliers, MOS memories: Introduction, DRAM and SRAM.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative list of Experiments	• Adder circuit • SRAM Cell design • CMOS Circuit design • SPICE simulation	

Course Code: ECVB 513	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**SEMICONDUCTOR PACKAGING AND TESTING**			
Course Coordinator				
Course Objectives	To enhance the knowledge of packaging and testing technology of semiconductor devices			

Course Outcomes		**Cognitive Levels**
CO1	Understand various packaging types used along with associated thermal, speed, signal, and integrity power issues.	Understand (Level-II)
CO2	Plan the design of packages that can withstand higher temperatures, vibrations, and shock.	Apply (Level-III)
CO3	Design of PCBs that minimize the EMI and operate at a higher frequency	Create (Level-VI)
CO4	Analyze the concepts of Testing and testing methods.	Analyze (Level-IV)

Semester	**7th**		**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Fundamentals of Microsystems Packaging
	Author	Rao R. Tummala
	Publisher	McGraw Hill, NY.
	Edition	2001
2.	Title	Advanced Electronic Packaging
	Author	William D. Brown
	Publisher	IEEE Press
	Edition	1999
Reference Books		
1.	Title	Printed Circuit Boards Design and Technology
	Author	Bosshart
	Publisher	TataMcGraw Hill
	Edition	1988

Course Contents	**UNIT I:** Overview of electronic systems packaging: Introduction and Objectives of the course definition of a system and history of semiconductors, Products and levels of packaging, Packaging aspects of handheld products. Semiconductor Packaging Overview: Basics of Semiconductor and Process flowchart; Video on "Sand-to-Silicon", Wafer fabrication, inspection and testing, Wafer packaging; Packaging evolution, Chip connection choices, Wire bonding, TAB and flipchip-1, TAB and flipchip-2, Need for packaging & Single chip packages or modules (SCM),	**9**

	Commonly used packages and advanced packages, Materials in packages, Thermal mismatch in packages, Current trends in packaging, Multichip modules (MCM)-type, System-in- package (SIP), Packaging roadmaps, Hybrid circuits.	
	UNIT II: Electrical Design considerations in systems packaging: Electrical Issues – I Resistive Parasitic, Electrical Issues – II; Capacitive and Inductive Parasitic, Electrical Issues – III; Layout guidelines and the Reflection problem, Electrical Issues – IV; Interconnection, CAD for Printed Wiring Boards: Benefits from CAD; Introduction to DFM, DFR & DFT, Components of a CAD package and its highlights, Design Flow considerations; Beginning a circuit design with schematic work and component layout, Demo and examples of layout and routing; Technology file generation from CAD; DFM checklist and design rules; Design for Reliability.	**9**
	UNIT III: Printed Wiring Board Technologies: Board-level packaging aspects, Review of CAD output files for PCB fabrication, Photo plotting, and mask generation, Process flow-chart; Vias; PWB substrates, Surface preparation, Photoresist and application methods, UV exposure and developing, Printing technologies for PWBs, PWB etching, Resist stripping, Screen-printing technology, Through-hole manufacture process steps, Panel and pattern plating methods, Solder mask for PWBs, Multilayer PWBs; Introduction to microvias, Microvia technology, and Sequential build-up technology process flow for high-density interconnects, Conventional Vs HDI technologies; Flexible circuits.	**9**
	UNIT IV: Surface Mount Technology: SMD benefits; Design issues; Introduction to soldering, Reflow, and Wave Soldering methods to attach SMDs, Solders: Wetting of solders; Flux and its properties, Defects in wave soldering, Vapor phase soldering, BGA soldering, and de-soldering/ Repair, SMT failures, SMT failure library, Tin Whiskers, Tin-lead, and lead-free solders; Phase diagrams, Thermal profiles for reflow soldering, Lead-free alloys, Lead-free solder considerations; Green electronics; RoHS compliance, e-waste recycling issues.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECVB 514	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course/ Lab Course
Course Title	**ALGORITHM FOR VLSI DESIGN**
Course Coordinator	
Course Objectives	To provide the understanding of the theoretical as well as practical concepts of the designing algorithms for CAD tools for VLSI design.

Course Outcomes		**Cognitive Levels**
CO1	Understand the VLSI synthesis techniques.	Understand (Level-II)
CO2	Analyze the VLSI algorithms for automation.	Analyze (Level-IV)
CO3	Apply the algorithm for floor planning and configuration.	Apply (Level-III)
CO4	Able to understanding concept of global and detailed routing in VLSI.	Understand (Level-II)

Semester	**6th**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Algorithms for VLSI physical design Automation
	Author	Naveed Shervani
	Publisher	Kluwer Academic Publisher
	Edition	3rd edition, 1999
2.	Title	Algorithm and Data Structures for VLSI Design
	Author	Christophn Meinel & Thorsten Theobold
	Publisher	Kluwer Academic Publisher
	Edition	2002

Reference Books		
1.	Title	Evolutionary Algorithm for VLSI CAD
	Author	Rolf Drechsheler
	Publisher	Kluwer Academic Publisher
	Edition	2nd edition 2010

Course Contents		
	UNIT I: Logic synthesis & verification: Introduction to combinational logic synthesis, Binary decision diagram, Hardware models for High-level synthesis.	**9**
	UNIT II: VLSI automation Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms.	**9**

	UNIT III: Placement, floor planning & pin assignment: Problem formulation, simulation base placement algorithms, other placement algorithms, constraint-based floor planning, floor planning algorithms for mixed block & cell design. General & channel pin assignment.	**9**
	UNIT IV: Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches Detailed routing: Problem formulation, classification of routing algorithms, single layer routing algorithms, two-layer channel routing algorithms, three-layer channel routing algorithms, and switchbox routing algorithms.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code	**:**	**ECVP 515**				
Course Title	**:**	**Programming Lab**				
Type of Course	**:**	**Program Core**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		0	0	4	2	32 (P)
Pre-requisite	**:**	Nil				
Programming lab related to the Microelectronics/VLSI domain.						

Course Code	**:**	**ECVP 516**				
Course Title	**:**	**Seminar / Summer Internship - I**				
Type of Course	**:**	**Program Core**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		0	0	2	1	-
Pre-requisite	**:**	Nil				
Seminar / Summer Internship related to Microelectronics/VLSI domain						

Course Code: ECVB 617	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**PC Course: (Y/N)**	**PE Course: (Y/N)**
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**EMBEDDED AND REAL TIME OPERATING SYSTEMS**			
Course Coordinator				
Course Objectives	To provide the fundamental knowledge of embedded and real-time operating systems and RAM and ROM			

Course Outcomes		**Cognitive Levels**
CO1	Explain the basics of an embedded system and its approaches.	Understand (Level-II)
CO2	Identify the various methods of Hardware Implementation.	Apply (Level-III)
CO3	Analyze the clocking issues in embedded systems.	Analyze (Level-IV)
CO4	Compile the operating systems concepts, types and RTOS.	Create (Level-VI)

Semester	**6th**	**Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Introduction to Embedded Systems
	Author	Shibu K. V
	Publisher	Mc Graw Hill
	Edition	2013
2.	Title	Embedded Systems
	Author	Lyla
	Publisher	Pearson
	Edition	2013

Reference Books		
1.	Title	An Embedded Software Primer
	Author	David E. Simon
	Publisher	Pearson
	Edition	2013

Course Contents		
	UNIT I: Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	**9**
	UNIT II: Typical Embedded System: Core of the Embedded System: General Purpose	**9**

	and Domain Specific Processors, ASICs, PLDs, Commercial Off- The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces	
	UNIT III: Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages. ATMega and Resberi Pi.	**9**
	UNIT IV: RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling. Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECVB 618	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N
Type of Course	Theory Course/ Lab Course			
Course Title	**ANALOG VLSI DESIGN**			
Course Coordinator				
Course Objectives	To develop insight of Analog MOS device and amplifiers, their frequency response and stability analysis			

Course Outcomes		**Cognitive Levels**
CO1	Understanding the MOS Operation and small signal models.	Understand (Level-II)
CO2	Analyze single-stage amplifiers with different loads.	Analyze (Level-IV)
CO3	To design single and differential CMOS amplifiers	Create (Level-VI)
CO4	Understanding the role of feedback in amplifiers.	Understand (Level-II)

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Design of Analog CMOS Integrated Circuits
	Author	Behzad Razavi
	Publisher	McGraw Hill Education
	Edition	2000
2.	Title	CMOS Analog Circuit Design
	Author	Phillip Allen and Douglas R. Holberg
	Publisher	OUP USA
	Edition	3rd Edition, 2011
Reference Books		
1.	Title	Operation and Modelling of the MOS Transistor
	Author	Yannis Tsividis
	Publisher	Oxford University Press
	Edition	2ndedition, 2003

Course Contents		
	UNIT I: Introduction to MOSFETS, Simple MOSFET circuits, Threshold voltage model, Capacitance model, MOSFET basics, Device Structure and Operation, General Considerations, MOS I/V Characteristics, Finite Output Resistance in Saturation, Transconductance, Second Order effects: body effect, Channel length modulation, Subthreshold conduction, MOS small signal models, SPICE, Short Channel Effects: DIBL, velocity saturation, hot carrier, impact ionization, surface scattering.	**9**
	UNIT II:	**9**

	Amplifiers: Basic concepts, Single Stage Amplifiers: Basic Concepts, Common Source Stage: resistive load, diode connected load, current source load, triode load, source degeneration. Source Follower, Common Gate Stage, Cascode Stage. Folded cascode. Differential Amplifiers: Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell.	
	UNIT III: Basic current mirrors, Cascode current mirrors, Active current mirrors with large and small signal analysis, Feedback topologies (voltage-voltage, current-voltage, voltage-current, current-voltage), loading effect analysis, Negative feedback, Stability of negative feedback systems, Stability and frequency compensation. Frequency Response of Amplifiers: Amplifier transfer function, General Considerations, Miller Effect, Common Source Stage, Source Followers, Common Gate Stage.	**9**
	UNIT IV: Design of the CMOS operational amplifiers: One-stage opamps and two-stage opamps, Gain boosting techniques, folded cascode, telescopic amplifier, common mode feedback (CMFB) amplifier, Input Range limitations, Slew Rate, Power Supply Rejection, VCO Circuit design, OTA design.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code	**:**	**ECVP 619**				
Course Title	**:**	**Minor Project**				
Type of Course	**:**	**Program Core**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		0	0	4	2	--
Pre-requisite	**:**	Nil				
Minor Project related to the Microelectronics/VLSI/ECE.						

Course Code	**:**	**ECVP 620**				
Course Title	**:**	**Project Based Learning**				
Type of Course	**:**	**Program Core**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Hours**
Contact Hours		0	0	2	1	--
Pre-requisite	**:**	Nil				
Project-based Learning related to Microelectronics/VLSI/ECE.						

Course Code: ECVL 721	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**PC Course: (Y/N)**	**PE Course: (Y/N)**
	N	N	Y	N
Type of Course	Theory Course			
Course Title	**LOW-POWER VLSI DESIGN**			
Course Coordinator				
Course Objectives	To provide the fundamental knowledge of VLSI systems using CMOS technology for low power and high-performance applications			

Course Outcomes		**Cognitive Levels**
CO1	To understand the importance of low power design.	Understand (Level-II)
CO2	To study the various source of power consumption in CMOS circuits.	Understand (Level-II)
CO3	To apply the techniques to reduce the power dissipation in CMOS circuits.	Apply (Level-III)
CO4	To analyse the circuit with probabilistic power technique.	Analyze (Level-IV)

Semester	**6th**	**Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	CMOS Digital Integrated Circuits
	Author	Sung Mo Kang, Yusuf Leblebici
	Publisher	Tata McGraw Hill
	Edition	2nd edition, 2003
2.	Title	Principles of CMOS VLSI Design
	Author	Neil H. E. Weste and K. Eshraghian
	Publisher	Addison Wesley (Indian reprint).
	Edition	2nd Edition
Reference Books		
1.	Title	Low Power VLSI CMOS Circuit Design
	Author	A. Bellamour, and M. I. Elmasri
	Publisher	Kluwer Academic Press
	Edition	1995

Course Contents	**UNIT I:** Introduction: Motivation for low power VLSI design, Sources of power dissipation in Digital Integrated circuits. Emerging Low power approaches. Dynamic dissipation in CMOS, Effect of supply voltage and Threshold voltage, Impact of technology Scaling, Technology & Device innovation. Circuit Techniques for low power design: techniques for leakage power reduction. Low-Power Design Through Voltage Scaling, Estimation and Optimization of Switching Activity, Reduction of Switched Capacitance.	**9**

	UNIT II: SPICE circuit simulation, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis. Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.	**9**
	UNIT III: Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganization. Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. Energy Recovery CMOS: energy dissipation in transistor channel using RC model, adiabatic dynamic logic circuit.	**9**
	UNIT IV: Leakage Power minimization Approaches: Variable-threshold-voltage CMOS (VTCMOS) approach multi-threshold-voltage CMOS (MTCMOS) approach Power gating Transistor stacking Dual-Vt assignment approach (DTCMOS)	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECVL 722	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	Y	N

Type of Course	Theory Course/ Lab Course
Course Title	**VLSI VERIFICATION AND TESTING**
Course Coordinator	
Course Objectives	To provide the fundamental knowledge of fault detection and corrective analysis for VLSI circuits

Course Outcomes		**Cognitive Levels**
CO1	Understand the requirement of fault modelling in VLSI circuits.	Understand (Level-II)
CO2	Analyze test vectors to test a circuit efficiently covering maximum faults.	Analyze (Level-IV)
CO3	Apply the concept of Memory testing techniques	Apply (Level-III)
CO4	Evaluate Built-in-Self Test and its application in modern digital design	Evaluate (Level-V)

Semester	**7th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Essentials of Electronic Testing
	Author	M. L. Bushnell and V. D. Agrawal
	Publisher	Kluwer Academic Publishers
	Edition	3rd edition2002
2.	Title	Delay Fault Testing for VLSI Circuits
	Author	A. Krstic and K-T Cheng
	Publisher	Kluwer Academic Publishers
	Edition	3rd edition 2003
Reference Books		
1.	Title	Testing of Digital Systems
	Author	N. K. Jha and S. Gupta
	Publisher	Cambridge University Press
	Edition	2nd edition 2003

Course Contents	**UNIT I:** Physical faults and their modelling. Fault equivalence and dominance; fault collapsing, Fault simulation: parallel, deductive and concurrent techniques; critical path tracing.	**9**

	UNIT II: Test generation for combinational circuits: Boolean difference, D-algorithm, Podem, random etc. Exhaustive, random and weighted test pattern generation; aliasing and its effect on fault coverage. PLA testing: cross-point fault model, test generation, easily testable designs. Memory testing: permanent, intermittent and pattern-sensitive faults; test generation.	**9**
	UNIT III: Delay faults and hazards; test pattern generation techniques, ATPG and its different types Test pattern generation for sequential circuits: ad-hoc and structures techniques scan path and LSSD, boundary scan	**9**
	UNIT IV: Built-in self-test techniques: LBIST and MBIST. Verification: logic level (combinational and sequential circuits), RTL-level (data path and control path). Verification of embedded systems. Use of formal techniques: decision diagrams, logic-based approaches. ASIC/IP Verification, direct and random testing, Error detection and correction codes.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative list of Experiments	Course coordinator will frame the list of experiment as per theory content of course.	

Course Code: HMVL 703	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**ENGINEERING ECONOMICS AND ACCOUNTING**			
Course Coordinator				
Course Objectives	To gain the fundamental knowledge of management principles, organization and their structure			

Course Outcomes		**Cognitive Levels**
CO1	Understand the objective and principles of management	Understand (Level-II)
CO2	Apply the management planning technique and decision-making process	Apply (Level-II)
CO3	Analyze the architecture of organization and departments	Analyze (Level-IV)
CO4	Predict the nature of directions and coordination	Create (Level-VI)

Semester	**7th**	**Autumn**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Management-Tasks, Responsibilities & Practices
	Author	Drucker, F. Peter
	Publisher	TRUMAN TALLEY BOOKS
	Edition	1st Edition
2.	Title	Organizational Behaviour
	Author	C.H Dubey
	Publisher	Prentice Hall in India (PHI)
	Edition	2015

Reference Books		
1.	Title	C. B. Gupta
	Author	Human Resource Management
	Publisher	Sultan Chand & Sons
	Edition	2006

Course Contents		
	UNIT I: Management Concept and Definition, Nature of Management, Objectives of Management, Significance of Management, Managerial Roles and Managerial Skills, Management and Administration, Levels of Management, Management Process and Functions, Functional Areas of Management, Management Principles- General and Scientific Management, Evolution of Management Thought, Approaches of Management Thought.	**9**
	UNIT II: Planning definition and nature, Importance of Planning, Planning Process,	**9**

	Need for Planning, Principles of Planning, Types of Planning, Advantages and Disadvantages of Planning; Decision making concept, Characteristics of Decision Making, Types of Decisions, Decision Making Process, Characteristics of Effective Decisions, Rationality in Decision Making.	
	UNIT III: Organizing definition. Organisation as a Process, Organisation Structure, Principles of Organisation, Importance of Organisation, Types of Organisations. Departmentation- Meaning, Need and Significance of Departments, Process involved in Departmentation, Methods or Basis of Departmentation; Span of Management; Centralization and Decentralisation; Delegation.	**9**
	UNIT IV: Directing concept, Nature and Characteristics of Directing, Principles of Directing; Motivation- Concept and Theories of motivation; Concept of Leadership- Theories and Styles; Communication Process, Channels and Barriers, Effective Communication. Coordination- Concept and Nature of Coordination, Need for coordinating; Importance, Principles and Techniques of Coordination; Process of Coordination. Controlling- Definitions, Characteristics of Controlling, Steps in Control Process, Types of Controlling, Control Techniques.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code	**:**	**ECVP 723**				
Course Title	**:**	**Seminar / Summer Internship - II**				
Type of Course	**:**	**Program Core**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		0	0	2	1	-
Pre-requisite	**:**	Nil				
Seminar / Summer Internship related with the Microelectronics/VLSI /ECE.						

SEMESTER-VIII

Course Code	**:**	**ECVP 824**				
Course Title	**:**	**MAJOR PROJECT / INTERNSHIP**				
Type of Course	**:**	**Project**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Lab Hours**
Contact Hours		-	-	-	16	-
Pre-requisite	**:**	Nil				
Major Project / Internship related to Microelectronics/VLSI/ECE.						

Course Code	**:**	**ECVP 825**				
Course Title	**:**	**Independent study and Seminar**				
Type of Course	**:**	**Seminar / Internship / Independent study**				
		Lecture	**Tutorial**	**Practical**	**Credits**	**Total Hours**
Contact Hours		-	-	-	4	-
Pre-requisite	**:**	Nil				
Seminar / Internship / Independent study related with the Microelectronics/VLSI /ECE.						

Program Electives and Open Electives for B.Tech VLSI Design and Technology

List of Electives

Bouquet 1: Elective-I

S. No.	Course Code	Course Title	L	T	P	Credits
1.	PEVL 501	Semiconductor Device Modelling	3	0	0	3
2.	PEVL 502	Introduction to Machine Learning	3	0	0	3
3.	PEVL 503	Internet of Things	3	0	0	3
4.	PEVL 504	Wireless Communication	3	0	0	3
5.	PEVL 505	Digital Signal Processor and Architecture	3	0	0	3
6.	PEVL 506	Antenna Theory and Design	3	0	0	3

Bouquet 2: Elective-II and Elective III

S. No.	Course Code	Course Title	L	T	P	Credits
1.	PEVL 607	Introduction to MEMS	3	0	0	3
2.	PEVL 608	Nano Electronics	3	0	0	3
3.	PEVL 609	Cyber Security	3	0	0	3
4.	PEVL 610	ASIC and FPGA Design	3	0	0	3
5.	PEVL 611	Radar Engineering	3	0	0	3
6.	PEVL 612	Advance Neural Network	3	0	0	3
7.	PEVL 613	VLSI Interconnects	3	0	0	3
8.	PEVL 614	AI and Machine Learning for IC	3	0	0	3
9.	PEVL 615	VLSI for Communications	3	0	0	3
10.	PEVL616	Memory Devices and circuits	3	0	0	3

Bouquet 3: Elective-IV and Elective V

S. No.	Course Code	Course Title	L	T	P	Credits
1.	PEVL 717	CAD for VLSI	3	0	0	3
2.	PEVL 718	Thin Films Characterization	3	0	0	3
3.	PEVL 719	Mixed Signal IC design	3	0	0	3
4.	PEVL 720	Bio-Medical Electronics	3	0	0	3
5.	PEVL 721	RF Microelectronics	3	0	0	3
6.	PEVL 722	High-Speed Interfacing Circuits	3	0	0	3
7.	PEVL 723	Digital Image Processing	3	0	0	3
8.	PEVL 724	Flexible Electronics	3	0	0	3
9.	PEVL 725	Quantum Computing	3	0	0	3
10.	PEVL 726	Solar Cell Technology	3	0	0	3
11.	PEVL 727	Ad-hoc Sensor Networks	3	0	0	3
12.	PEVL 728	Full Custom Design	3	0	0	3
13.	PEVL 729	Advance Semiconductor Manufacturing	3	0	0	3
14.	PEVL 730	Data Converters	3	0	0	3
15.	PEVL 731	Reconfigurable Computing System and Applications	3	0	0	3

Open Elective-I

S. No.	Course Code	Course Title	L	T	P	Credits
1.	OEVL 601	Growth, Fabrication and Manufacturing of Electronic Devices	3	0	0	3
2.	OEVL 602	Electronic Materials	3	0	0	3
3.	OEVL 603	Basics of IC Design	3	0	0	3

Open Elective-II

S. No.	Course Code	Course Title	L	T	P	Credits
1.	OEVL 704	Data Communication and Networking	3	0	0	3
2.	OEVL 705	Micro-Electronics and VLSI Technology	3	0	0	3
3.	OEVL 706	Embedded and real time operating systems	3	0	0	3

Course Code: PEVL 501	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course/ Lab Course			
Course Title	**SEMICONDUCTOR DEVICE MODELLING**			
Course Coordinator				
Course Objectives	To enhance the knowledge of semiconductor devices, various and their characteristics.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the equations, approximations, and techniques available for deriving a model with specified properties, for a general device characteristic with known qualitative theory.	Understand (Level-II)
CO2	Apply suitable approximations and techniques to derive the model starting from drift-diffusion transport equations.	Apply (Level-III)
CO3	Examine clues to a qualitative understanding of the physics of a new device and conversion of this understanding into equations.	Evaluate (Level-V)
CO4	Compile characteristics of a simple device using MATLAB, and SPICE tools.	Create (Level-VI)

Semester	**5th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Solid State Electronic Devices
	Author	B. G. Streetman and S. Banerjee
	Publisher	PHI Private Limited
	Edition	2011
2.	Title	Introduction to Device Modelling and Circuit Simulation
	Author	T. A. Fjeldly, T. Ytterdal, and M. Shur
	Publisher	John Wiley and Sons
	Edition	1998
Reference Books		
1.	Title	Introduction to Semiconductor Materials and devices
	Author	M.S Tyagi
	Publisher	John Wiley & Sons
	Edition	2005

Course Contents	**UNIT I:** Semiconductors in Equilibrium and Carrier Transport, Semiconductor Materials, Carrier Concentration, Carrier Drift, Carrier Diffusion, Generation and Recombination Process, Continuity Equation, Thermionic Emission, Tunnelling, Ballistic Transport, High Field Effects. Physics of Junction Devices: Thermal Equilibrium Condition, Depletion region, Depletion, and Diffusion Capacitances, Current-Voltage characteristics, Charge Storage and Transient behaviour, Junction Breakdown, Metal Semiconductor	**9**

	Contacts, forward and reverse-biased junctions, reverse bias breakdown, transient, and a-c conditions.	
	UNIT II: Physics of Bipolar devices: Transistor action, Static Characteristics, minority carrier distribution and terminal currents, generalized biasing, secondary effects, Frequency Response and Switching, Semiconductor Heterojunctions.	**9**
	UNIT III: Field-Effect Transistors: JFET- current-voltage characteristics, effects in real devices, high-frequency and high-speed issues, Metal Insulator Semiconductor FET. MOSFET- basic operation and fabrication, ideal MOS capacitor, Energy band diagram in equilibrium and under bias, Flat band voltage, Potential Balance and charge balance, Effect of gate body voltage on surface condition, Accumulation and depletion, Inversion, CV Characteristics, Frequency response, threshold voltages, output and transfer characteristics of MOSFET, short channel and Narrow width effects, MOSFET scaling.	**9**
	UNIT IV: Optoelectronics Devices: Light emitting diodes, Lasers, Photoconductors, Junction Photodiodes, Avalanche Photodiodes, Solar Cells, SPICE Models for Semiconductor Devices: MOSFET Level 1, Level 2 and level 3 model, Model parameters; SPICE models of p-n diode and BJT.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 502	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course/ Lab Course
Course Title	**DIGITAL IMAGE PROCESSING**
Course Coordinator	
Course Objectives	To gain the knowledge of different transforms, segmentation and compression of images signals for digital application.

Course Outcomes		**Cognitive Levels**
CO1	Analyze images in the frequency domain using various transforms.	Analyze (Level-IV)
CO2	Evaluate the techniques for image enhancement and image restoration.	Evaluate (Level-V)
CO3	Categorize various compression techniques.	Analyze (Level-IV)
CO4	Interpret Image compression standards, segmentation and representation techniques.	Evaluate (Level-V)

Semester	**5th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Digital Image Processing
	Author	R. C. Gonzalez and R. E. Woods
	Publisher	Pearson Education
	Edition	Third edition, 2009
2.	Title	Fundamental of Digital Image Processing
	Author	Anil K Jain
	Publisher	Prentice Hall
	Edition	1989

Reference Books		
1.	Title	The essential guide to image processing
	Author	A. C. Bovik
	Publisher	Academic Press
	Edition	Second edition 2009

Course Contents	**UNIT I:** Introduction to digital image processing: What is image processing, Different types of images, Visual perception, Image sensing and Acquisition, Quantization, Sampling, colour image processing, Revision of Mathematical concepts for image processing, Intensity transformation, Filtering in spatial and Frequency domain: Image negatives, Log transformations, Histogram processing, Spatial filter: smoothing and Sharpening, Discrete Fourier transform, properties of 2-D DFT, Image smoothing and Sharpening in Fourier domain	**9**

	UNIT II: Image transforms: Two-dimensional orthogonal and Unitary transforms, Optimum transform, Properties of Unitary transforms, 2D DFT, Cosine transforms, Hadamard transforms, KL transforms, Comparison of image transforms, Edge detection: Gradient and Laplacian based edge detection, Diffusion based edge detection: Isotropic and anisotropic diffusion.	**9**
	UNIT III: Wavelet transform for Image Processing: Multi resolution expansion, Wavelet functions, Wavelet Series expansion, Continuous and Discrete Wavelet transforms, Wavelet transforms for two dimensional signals (images), Applications of wavelet transforms for edge extraction, noise suppression.	**9**
	UNIT IV: Image segmentation: Thresholding, region-based Morphological Watersheds, Bayesian-base image segmentation. Image restoration and reconstruction: Models of image degradation, noise models, Spatial and Frequency domain-based approaches for image restoration, Inverse filtering, Wiener Filtering, Bayesian denoising. Image Compression: Spatial and Temporal redundancy, Basic image compression models, compression standards, basic compression methods: Huffman coding, Run-length coding, Block transform coding, Predictive coding. Colour Image Processing: Colour Fundamentals, Colour Models, Colour transformation, smoothing, sharpening and edge detection in colour images.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 503	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course/ Lab Course
Course Title	**INTERNET OF THINGS**
Course Coordinator	
Course Objectives	To improve the knowledge of use of Internet of Things related with the electronic devices applications

Course Outcomes		**Cognitive Levels**
CO1	Understand different prototyping boards and their components. They will be able to choose an appropriate board/component for designing an IoT system.	Understand (Level-II)
CO2	Analyze the programming in off-the-shelf boards using respective IDEs have ability to choose appropriate libraries for interfacing with external sensors.	Analyze (Level-IV)
CO3	Develop different communication standards and technologies to choose appropriate communication technology for designing of IoT system.	Apply (Level-III)
CO4	Evaluate the Medium Access Protocols, routing algorithms and their implementations.	Evaluate (Level-V)

Semester	**5th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Internet of Things
	Author	Dr. Jeeva Jose
	Publisher	Khanna Book Publishing Company
	Edition	2018
2.	Title	Introduction to Security of Cyber-Physical Systems
	Author	Dr. Jeeva Jose & Vijo Mathew
	Publisher	Khanna Book Publishing Company
	Edition	2022

Reference Books

1.	Title	The Internet of Things: Enabling Technologies, Platforms, and Use Cases
	Author	Pethuru Raj and Anupama C. Raman
	Publisher	CRC Press
	Edition	2017

Course Contents	**UNIT I:** An introduction to IoT systems: Introduction and motivation of IoT systems, Hardware components of IoT systems: A quick overview of different components---micro-controllers, SoCs, communication modules, power supply	**9**

	and sensing modules---of off-the-shelf prototyping boards, e.g., Arduino UNO, MSP430 Launch Pad; Node MCU, STM32.	
	UNIT II: The software component of IoT systems: Introduction to IDEs for off-the-shelf boards, e.g., Arduino IDE, Waspmote IDE, Code composed studio; Contiki-OS and RIOT OS; 6LowPAN network stack; Sensor interfacing; GPIO programming. Communication paradigm of IoT systems: Different wireless standards, e.g., IEEE802.15.4, ZigBee, BLE, IEEE802.11; link layer technologies, Medium Access Control; Routing; Application layer protocols; Network topologies.	**9**
	UNIT III: Performance evaluation of IoT systems: Developing mathematical models for energy consumption, Optimal node placement, and resource allocation over wireless sensor networks to meet QoS requirements. Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. Implementation of IoT with Raspberry Pi (contd), Introduction to SDN, SDN for IoT.SDN for IoT (contd), Data Handling and Analytics.	**9**
	UNIT IV: Cloud Computing, Cloud Computing (contd), Sensor-Cloud. Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Industrial IoT (contd), Case Study: Agriculture, Healthcare and Activity Monitoring.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 504	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course/ Lab Course			
Course Title	**WIRELESS COMMUNICATION**			
Course Coordinator				
Course Objectives	To educate the students about the technology and advancements in modern wireless communication.			

Course Outcomes		**Cognitive Levels**
CO1	Discuss the cellular system design and technical challenges.	Understand (Level-II)
CO2	Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.	Analyze (Level-IV)
CO3	Analyze the design parameters, link design, smart antenna, beam forming and MIMO systems.	Analyze (Level-IV)
CO4	Analyze Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts. summarize the principles and applications of wireless systems and standards	Analyze (Level-IV)

Semester	**5th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

Text Books		
1.	Title	Wireless Communications
	Author	A.F.Molisch
	Publisher	Wiley
	Edition	2005
2.	Title	Wireless Communications
	Author	A.Goldsmith
	Publisher	Cambridge University Press
	Edition	2005
Reference Books		
1.	Title	Wireless Communication"s
	Author	P.Muthu Chidambara Nathan
	Publisher	PHI
	Edition	2008

Course Contents		
	UNIT I: Introduction to Wireless Communication. The Cellular concept, System design, Capacity improvement in cellular systems, Co channel interference reduction. Intelligent cell concept and applications. Technical Challenges.	**9**
	UNIT II: Mobile radio propagation: Reflection, Diffraction. Fading. Multipath Propagation. Channel modeling, Diversity Schemes and Combining Techniques.	**9**

	UNIT III: Design parameters at the base station, Practical link budget design using path loss models. Smart antenna systems, Beamforming. MIMO Systems. RAKE receiver.	**9**
	UNIT IV: Multiuser Systems: CDMA- Principle, Network design, Link capacity, Power control, WCDMA-Network planning, MC-CDMA, OFDM, Cellular mobile communication beyond 3G. GSM, IS-95, GPRS, UMTS, WLAN, WPAN, WMAN, Ultra-Wideband communications, 4G and beyond 4G.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 505	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course/ Lab Course
Course Title	**DIGITAL SIGNAL PROCESSOR AND ARCHITECTURE**
Course Coordinator	
Course Objectives	To educate the students about the architecture and programmable digital signal processing

Course Outcomes		**Cognitive Levels**
CO1	Understand Architectures for programmable DSP devices	Understand (Level-II)
CO2	Analyze the Execution, control and pipelining of DSP devices	Analyze (Level-IV)
CO3	Examine Programmable digital signal processors	Apply (Level-III)
CO4	Apply the basic DSP algorithms	Apply (Level-III)

Semester	**5th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Digital Signal Processors, Architecture, Programming and Applications
	Author	B. Venkataamani and M. Bhaskar
	Publisher	TMH
	Edition	2004
2.	Title	Digital Signal Processing- A practical approach
	Author	Ifeachor & Jervis
	Publisher	Pearson Education
	Edition	2005

Reference Books

1.	Title	TMS320C50, TMS320C54XX, TMS320C6713 databooks
	Author	
	Publisher	
	Edition	

Course Contents	**UNIT I:** ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing.	**9**
	UNIT II: EXECUTION CONTROL AND PIPELINING: Hardware looping, Interrupts,	**9**

	Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branching effects, Interrupt effects, and Pipeline Programming models.	
	UNIT III: PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline Operation of TMS320C54XX Processors.	**9**
	UNIT IV: IMPLEMENTATIONS OF BASIC DSP ALGORITHMS: The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing, FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX, Computation of the signal spectrum.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 506	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course/ Lab Course			
Course Title	**ANTENNA THEORY AND DESIGN**			
Course Coordinator				
Course Objectives				

Course Outcomes		**Cognitive Levels**
CO1	Understand the Antenna theory, Radiation Pattern and wave equations.	Understand (Level-II)
CO2	Analyze the Antenna dipoles, loop pattern and Antenna array.	Analyze (Level-IV)
CO3	Examine the types of Antenna and their configuration.	Evaluate (Level-V)
CO4	Design the Antenna at microlevel and study their characteristics.	Create (Level-VI)

Semester	**5th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Antenna Theory Analysis and Design
	Author	C. A. Balanis
	Publisher	Wiley Publication
	Edition	3rd Edition
2.	Title	Antennas: For All Applications
	Author	Kraus, John D &, Ronald J Marhefka
	Publisher	Tata McGraw Hill
	Edition	3rd Edition

Reference Books		
1.	Title	Antenna Theory and Design
	Author	W. L. Stutzman and G. A. Thiele
	Publisher	Wiley Publication
	Edition	2005

Course Contents		
	UNIT I: Review of electromagnetic theory, Antenna and their different types, Radiation Mechanism and Current Distribution, Fundamental Parameters related to antenna (Radiation Pattern, Radiation Power Density, Directivity, Gain, Beam width, Antenna Efficiency, Bandwidth, Polarization, Radiation Efficiency, Antenna Factor) Radiation Integrals, Auxiliary Potential Functions and Construction of Solution, Solution of the inhomogeneous vector Potential Wave Equation, Far Field Radiation	**9**
	UNIT II: Infinitesimal dipole, Small Dipole, Finite length and Half-Wavelength Dipole –	**9**

	Analysis using assumed current Distribution Small Circular loop, Circular Loop with constant current, Two Element Array N-Element Linear Array with uniform amplitude and spacing, Broadside and End-Fire Array, N-Element Linear Array: Three-Dimensional Characteristic	
	UNIT III: Long Wire – Designing, V and Rhombic Antenna – Designing, Helical Antenna – Designing of normal and axial mode, rectangular apertures with different configurations- --With analysis Circular Apertures, E-Plane Sectoral Horn – Analysis and Design, H-Plane Sectoral Horn – Analysis and Design Pyramidal Horn	**9**
	UNIT IV: Basic of Microstrip Antenna, Designing of Rectangular Microstrip Antenna, Antenna Ranges, Gain Measurement, Radiation Pattern Measurement, Anechoic Chamber	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 607	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**INTRODUCTION TO MEMS**			
Course Coordinator				
Course Objectives	To educate the learners about micro machines, materials and systems for MEMS Devices			

Course Outcomes		**Cognitive Levels**
CO1	Understand fundamental principles of sensing and actuation and corresponding scaling laws in MEMS.	Understand (Level-II)
CO2	Construct a comprehensive perspective of various fabrication processes and materials used in microfabrication.	Apply (Level-III)
CO3	Examine the principle, design, and fabrication techniques of leading exemplary devices in the MEMS industry.	Analyze (Level-IV)
CO4	Design the basic MEMS devices using relevant mechanical/electrical/fluidic engineering principles.	Create (Level-VI)

Semester	**6th**	**Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Fundamentals of Microfabrication and Nanotechnology
	Author	Marc Madou
	Publisher	3rd edition
	Edition	2018
2.	Title	Microsystem Design
	Author	Microsystem Design
	Publisher	Kluwer Academic Publishers
	Edition	2002
Reference Books		
1.	Title	Foundation of MEMS
	Author	Chang Liu
	Publisher	Pearson Education
	Edition	2nd edition 2011

Course Contents		
	UNIT I: Introduction to MEMS: Historical Background, Scaling Effects. Micro/Nano Sensors, Review of Basic MEMS fabrication modules, Oxidation, Deposition Techniques, Lithography (LIGA), and Etching.	**9**
	UNIT II: Micromachining, Surface Micromachining, sacrificial layer processes, Stiction, Bulk Micromachining, Isotropic Etching, and Anisotropic Etching, Wafer Bonding, Mechanics of solids in MEMS/NEMS.	**9**
	UNIT III:	**9**

	Micro-actuators and Micro-sensors: Micro-sensors, acoustic wave sensors, biomedical and Nano-sensors, chemical sensors, optical sensors, pressure sensors, thermal sensors, micro-actuation through thermal forces, SMA-Piezo electric crystals, and electrostatic forces, magnetic actuation, micro-grippers, micro-motors, micro-valves, micro-pumps, micro-accelerometers.	
	UNIT IV: Materials, Mechanics and design of micro-systems: Silicon as a substrate, compounds, piezo-resistors, polymers, and packaging materials, micro-fabrication and micro-etching: static bending of thin plates, thermos-mechanics and thin film mechanics.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 608	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course/ Lab Course
Course Title	**NANOELECTRONICS**
Course Coordinator	
Course Objectives	To improve the fundamentals of electronic for nano-size devices

Course Outcomes		**Cognitive Levels**
CO1	Understand the fundamentals of classical CMOS technology and the issues in scaling MOSFET in the sub-100nm regime.	Understand (Level-II)
CO2	Analyze the non-classical transistors with new device structures and nanomaterials.	Analyze (Level-IV)
CO3	Identify the issues in realizing Germanium and compound semiconductor MOSFET.	Apply (Level-III)
CO4	Evaluate extensive materials characterization techniques that help in designing high-performance transistors.	Evaluate (Level-VI)

Semester	**6th**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Fundamentals of Modern VLSI Devices
	Author	Y. Taur and T. Ning
	Publisher	Cambridge University Press
	Edition	2nd edition 2009
2.	Title	Silicon VLSI Technology
	Author	Plummer, Deal
	Publisher	Griffin Pearson Education India
	Edition	2000

Reference Books

1.	Title	Encyclopaedia of Materials Characterization
	Author	Brundle, C.Richard; Evans, Charles A. Jr.;Wilson, Shaun
	Publisher	Elsevier
	Edition	1992

Course Contents		
	UNIT I: Overview: Nano-devices, Nano materials, Nano characterization, Definition of Technology node, Basic CMOS Process flow, MOS Scaling theory, Issues in scaling MOS transistors: short channel effects, Description of a typical 65 nm CMOS technology. Requirements for Non-classical MOS transistor, MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO2 vs High-k gate dielectrics. Integration issues of high-k Interface states, bulk charge, band offset, stability, reliability – Q_{bd} high field, possible candidates, CV and IV techniques.	**9**
	UNIT II:	**9**

	Metal gate transistor: Motivation, requirements, Integration Issues, Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot. SOI - PDSOI and FDSOI, Ultrathin body SOI – double gate transistors, integration issues, Vertical transistors - FinFET and Surround gate FET, Metal source/drain junctions – Properties of Schottky junctions on Silicon, Germanium, and compound semiconductors-Work function pinning. Germanium Nano MOSFETs: strain, quantization, Advantages of Germanium over Silicon, PMOS versus NMOS.	
	UNIT III: Compound semiconductors – material properties, MESFETs Compound semiconductors MOSFETs in the context of channel quantization and strain, Heterostructure MOSFETs exploiting novel materials, strain and quantization.	**9**
	UNIT IV: Synthesis of Nanomaterials: CVD, Nucleation and Growth, ALD, Epitaxy, MBE. Compound semiconductor hetero-structure growth and characterization: Quantum wells and Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry. AFM. Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc. Applications and interpretation of results. Emerging nano materials: Nanotubes, nano-rods and other nano structures, LB technique, soft lithography etc. Microwave-assisted synthesis, Self-assembly etc.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 609	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course/ Lab Course
Course Title	**CYBER SECURITY**
Course Coordinator	
Course Objectives	To gain the fundamentals of security measures from cyber related threats

Course Outcomes		**Cognitive Levels**
CO1	Understand the concept of Cyber security and issues and challenges associated with it.	Understand (Level-II)
CO2	Analyze the cyber-crimes, their nature, legal remedies and as to how report the crimes through available platforms and procedures.	Analyze (Level-IV)
CO3	Inspect various privacy and security concerns on online social media and understand the reporting procedure of inappropriate content, underlying legal aspects and best practices for the use of social media platforms.	Analyze (Level-IV)
CO4	Develop the basic concepts and algorithms related to E-Commerce and digital payments.	Create (Level-VI)

Semester	**6th**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Introduction to Security of Cyber-Physical Systems
	Author	Dr. Jeeva Jose & Vijo Mathew
	Publisher	Khanna Book Publishing Company.
	Edition	2022
2.	Title	Cyber Crime and its Prevention in Easy Steps
	Author	Debtoru Chatterjee
	Publisher	Khanna Publishing House
	Edition	2022
Reference Books		
1.	Title	Cyber Attacks and Counter-Measures Made Simple
	Author	Debtoru Chatterjee
	Publisher	Khanna Publishing House
	Edition	2022

Course Contents		
	UNIT I: Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.	**9**
	UNIT II: Classification of cyber-crimes, Common cyber-crimes- cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi, Reporting of	**9**

	cyber-crimes, Remedial and mitigation measures, Legal perspective of cyber-crime, IT Act 2000 and its amendments, Cyber-crime and offences, Organisations dealing with Cyber-crime and Cyber security in India, Case studies.	
	UNIT III: Introduction to Social networks. Types of social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.	**9**
	UNIT IV: Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payment Settlement Act, 2007. End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third-party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 610	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course/ Lab Course			
Course Title	**ASIC AND FPGA DESIGN**			
Course Coordinator				
Course Objectives	Understand non-logic-design issues in ASIC and FPGA design, including timing, power, and verification.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the ASIC library and Design Flow.	Understand (Level-II)
CO2	Analyze the RAM ROM technology and interconnects using Xilinx.	Analyze (Level-IV)
CO3	Apply the logic synthesis ASIC schematic design and construction.	Analyze (Level-IV)
CO4	Evaluate the FPGA floor planning and design using Xilinx family.	Evaluate (Level-V)

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Application -Specific Integrated Circuits
	Author	M. J. S. Smith
	Publisher	Pearson Education
	Edition	2003
2.	Title	VHDL for programmable logic
	Author	Kevin Skahill, Jay Legenhausen
	Publisher	Addison–Wesley
	Edition	1997
Reference Books		
1.	Title	Digital Design: Principles and Practices
	Author	John F. Wakerly
	Publisher	PHI
	Edition	2nd edition, 1994

Course Contents		
	UNIT I: Introduction: ASICs, CMOS Logic and ASIC Library Design Types of ASICs - Design flow - CMOS transistors CMOS Design rules -Combinational Logic Cell – Sequential logic cell -Data path logic cell.	**9**
	UNIT II: Review of VHDL/Verilog, Anti fuse static RAM -EPROM and EEPROM	**9**

	technology, Xilinx I/O blocks. Programmable ASIC Interconnect	
	UNIT III: Logic Synthesis: Half gate ASIC -Schematic entry -Low level design language - PLA tools -EDIFCFI design representation. ASIC Construction, Floor Planning, Placement and Routing, System partition	**9**
	UNIT IV: FPGA partitioning: Floor planning -placement -physical design flow -global routing –detailed routing -special routing circuit extraction -DRC. Design using Xilinx family FPGA.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 611	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course/ Lab Course			
Course Title	**RADAR ENGINEERING**			
Course Coordinator				
Course Objectives	To introduce students to the basic concepts of radar communication and navigation.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the principles of Radar jamming and Radar range.	Understand (Level-II)
CO2	Analyze the target, their detection and interface	Analyze (Level-IV)
CO3	Analyze the CW Radar, Doplar Radar and Tracking Radar	Analyze (Level-IV)
CO4	Apply the pulse compression technique in Radar system	Apply (Level-III)

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Modern Radar System Analysis
	Author	David Barton. K
	Publisher	Artech House
	Edition	1988
2.	Title	Radar Design Principles Signal Processing and The Environment
	Author	Fred Nathanson E
	Publisher	McGraw Hill
	Edition	1969
Reference Books		
1.	Title	Radar Signals
	Author	Cook CE. Bernfield. M
	Publisher	Academic Press
	Edition	1967

Course Contents		
	UNIT I: Radar Range Equation: Radar fundamentals, Derivation of range equation, the search radar equation, Jamming and radar range with jamming, Radar clutter and radar range with clutter, Radar range with combined interferences sources.	**9**
	UNIT II: Theory of Target Detection: Noise and false alarms, Detection of one sample of	**9**

	signal with noise, Integration of pulse trains, Detection of fluctuating targets, CFAR, Optimum and matched filter Theory, Loss factors in detection. Targets and Interference: Definition of radar cross section, Radar cross section of simple and complex objects, Spatial distribution of cross section, Bistatic cross section.	
	UNIT III: CW and FM Radar: Doppler Effect, CW and FMCW Radar, Airborne Doppler Navigation, Multi frequency CW Radar. MTI Radar: Delay lines and line cancellers, Subclutter Visibility. MTI using range gates and filters, Pulse Doppler radar, Noncoherent MTI radar, Application of Digital signal processing to radar system. Tracking Radar: Different types of tracking techniques, tracking in range, Tracking in Doppler, Search Acquisition radar, Comparison of Trackers.	**9**
	UNIT IV: Introduction to Pulse Compression Radar: Height finding radars, Air traffic control Radars and data handling, Atmospheric effects of radar, Electromagnetic compatibility aspects, Airborne Radars, Synthetic Aperture Radar, Secondary surveillance Radars.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 612	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course/ Lab Course			
Course Title	**ADVANCE NEURAL NETWORK**			
Course Coordinator				
Course Objectives	To become familiar with several advanced machine-learning methods, and to code them efficiently in Python using current neural-network packages.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the concept of neurons and human brain in neural network	Understand (Level-II)
CO2	Analyze the error corrections and filtering techniques for neural network	Analyze (Level-IV)
CO3	Apply the back propagation algorithm in neural networks	Apply (Level-III)
CO4	Apply the feature mapping techniques for various models	Apply (Level-III)

Semester	**6th**	**Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Neural Networks: A comprehensive foundation
	Author	Simon Haykin
	Publisher	Pearson Education
	Edition	2nd Edition, 2004
2.	Title	Artificial Neural Networks
	Author	B. Vegnanarayana
	Publisher	Prentice Hall of India, Pvt. Ltd
	Edition	2005
Reference Books		
1.	Title	Neural Networks in Computer Intelligence
	Author	Li Min Fu
	Publisher	Tata McGraw Hill
	Edition	2003

Course Contents		
	UNIT I: Review of linear algebra, norms and distance concepts, classical optimization techniques, Lagrange multiplier method, derivative free optimization methods, no free lunch theorem, basics of probability theory, state variable analysis of dynamical systems. Human Brain, Models of a Neuron, Neural networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks.	**9**
	UNIT II:	**9**

	Error Correction learning, Memory based learning, Hebbian learning, Competitive, Boltzmann learning, Credit Assignment Problem, Memory, Adaption, Statistical nature of the learning process, Adaptive filtering problem, Unconstrained Organization Techniques, Linear least square filters, least mean square algorithm, learning curves, Learning rate annealing techniques, perception –convergence theorem, Relation between perception and Bayes classifier for a Gaussian Environment	
	UNIT III: Back propagation algorithm XOR problem, Heuristics, Output representation and decision rule, Computer experiment, feature detection, BACK PROPAGATION - back propagation and differentiation, Hessian matrix, Generalization, Cross validation, Network pruning Techniques, Virtues and limitations of back propagation learning, accelerated convergence, supervised learning.	**9**
	UNIT IV: Two basic feature mapping models, Self-organization map, SOM algorithm, properties of feature map, computer simulations, learning vector quantization, Adaptive patter classification, Hierarchal Vector quantizer, contexmel Maps, Dynamical systems, stability of equilibrium states, attractors, neurodynamical models, manipulation of attractors' as a recurrent network paradigm, Hopfield models.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 613	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**VLSI INTERCONNECTS**			
Course Coordinator				
Course Objectives	Introduce students to the basic interconnect parameters and its model. Students will learn Scaling and crosstalk issues of interconnects. They will also learn the repeater design methods and various advanced interconnects technique.			

Course Outcomes		**Cognitive Levels**
CO1	To understand the basic interconnect parameters and its model	Understand (Level-II)
CO2	TO study different scaling issues in interconnects.	Apply (Level-III)
CO3	To analyse theoretical and device level modelling of crosstalk.	Analyze (Level-IV)
CO4	To learn the repeater interconnects technique. design methods and various advanced	Understand (Level-II)

Semester	6th	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	High-Speed VLSI Interconnects,2007
	Author	Ashok K. Goel
	Publisher	Wiley-IEEE Press; 2nd edition
	Edition	2007
2.	Title	Advanced Nanoscale ULSI Interconnects: Fundamentals and Applications
	Author	Y.S. Diamand
	Publisher	Cambridge University Press
	Edition	2009
Reference Books		
1.	Title	Carbon nanotube and Graphene Device Physics
	Author	H.S Philip Wong and Deji Akinwande
	Publisher	Cambridge University Press
	Edition	2011

Course Contents	**UNIT I:** Introduction to VLSI Interconnect: Technological trends, Interconnect scaling, 3D interconnect view; Interconnect Parameters: Resistance, Inductance, and Capacitance, skin effect and its influence on resistance and inductance. Interconnect RC Delays: Elmore Delay Calculation. Interconnect Models: The lumped RC Model, the distributed RC Model, the transmission line model. SPICE Wire Models: Distributed RC lines in SPICE, Transmission line models in SPICE.	**9**

	UNIT II: Scaling issues in interconnects: Gate and Interconnect Delay; CMOS Repeater: The Static Behavior- Switching Threshold, Noise Margins, The Dynamic Behavior Computing the capacitances, Propagation Delay: First order Analysis, Propagation Delay from a Design perspective, Power, energy and Energy-Delay- Dynamic Power Consumption, Static Consumption, Analyzing Power Consumption using SPICE.	**9**
	UNIT III: Repeater Design: Driving Interconnects for Optimum speed and power; Short channel model of CMOS Repeater - Transient Analysis of an RC loaded CMOS repeater, Delay Analysis, Analytical power expressions: Dynamic power, Short circuit Power, Resistive Power Dissipation, CMOS Repeater insertion: Analytical expressions for delay and power of a repeater chain driving an RC load.	**9**
	UNIT IV: Advanced Interconnect Techniques: Reduced-swing Circuits, Current-mode Transmission Techniques Crosstalk: Theoretical basis and circuit level modeling of crosstalk, Energy dissipation due to crosstalk: Model for energy calculation of two coupled lines. Contribution of driver and interconnect to dissipated energy, Crosstalk effects in logic VLSI circuits: Static circuits, Dynamic circuits and various remedies.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 614	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course/ Lab Course			
Course Title	**AI AND MACHINE LEARNING FOR IC**			
Course Coordinator				
Course Objectives	To provide fundamentals of Programming for Artificial Intelligence and Machine Learning techniques			

Course Outcomes		**Cognitive Levels**
CO1	Introduce the fundamentals of AI, problem-solving, and basic search strategies.	Remember (Level-I)
CO2	Understand various AI search algorithms.	Analyze (Level-IV)
CO3	Introduce the fundamentals of machine learning, explore supervised learning techniques	Apply (Level-III)
CO4	Explore unsupervised learning techniques and introduce the fundamentals of reinforcement learning	Apply (Level-III)

Semester	**6th**	**Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Artificial Intelligence: A Modern Approach
	Author	Russell, Norvig
	Publisher	Prentice Hall
	Edition	Third edition, 2010.
2.	Title	MACHINE LEARNING An Algorithmic Perspective
	Author	Stephen Marsland
	Publisher	Taylor & Francis Group, LLC
	Edition	2nd Edition, 2015
Reference Books		
1.	Title	Introduction to Machine Learning
	Author	Ethem Alpaydın
	Publisher	The MIT Press, Cambridge, Massachusetts, London, England
	Edition	2nd Edition.

Course Contents		
	UNIT I: Introduction-AI problems, Agents and Environments, Structure of Agents, Problem Solving Agents Basic Search Strategies: Problem Spaces, Uninformed Search (Breadth-First, Depth-First Search, Depth-first with Iterative Deepening), Heuristic Search (Hill Climbing, Generic Best-First, A*), Constraint Satisfaction (Backtracking, Local Search)	**9**
	UNIT II: Advanced Search- Constructing Search Trees, Stochastic Search, AO* Search Implementation, Minimax Search, Alpha-Beta Pruning Basic Knowledge Representation and Reasoning: Propositional Logic, First-Order	**9**

	Logic, Forward Chaining and Backward Chaining, Introduction to Probabilistic Reasoning, Bayes Theorem	
	UNIT III: Machine-Learning- Introduction, Machine Learning Systems, Forms of Learning: Supervised and Unsupervised Learning, reinforcement – theory of learning – feasibility of learning – Data Preparation– training versus testing and split. Supervised Learning: Regression- Linear Regression, multi linear regression, Polynomial Regression, logistic regression, Non-linear Regression, Model evaluation methods. Classification: – support vector machines (SVM), Naïve Bayes classification	**9**
	UNIT IV: Unsupervised learning- Nearest neighbor models – K-means – clustering around medoids – silhouettes – hierarchical clustering – k-d trees, Clustering trees – learning ordered rule lists – learning unordered rule. Reinforcement learning- Example: Getting Lost -State and Action Spaces	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 615	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**VLSI FOR COMMUNICATION**			
Course Coordinator				
Course Objectives				

Course Outcomes		**Cognitive Levels**
CO1	Understand the concept of communication in VLSI. Understand the High Frequency model of MOS and importance of Impedance Matching.	Understand (Level-II)
CO2	Analyse the various transceiver and radio architectures.	Apply (Level-III)
CO3	Design Low Noise amplifiers and Mixers with specifications	Evaluate (Level-V)
CO4	Realize Oscillators and Frequency synthesizers and their applications to transceiver design.	Analyze (Level-IV)

Semester	6th	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

Text Books		
1.	Title	RF Microelectronics
	Author	B.Razavi
	Publisher	Pearson Education Limited
	Edition	Second Edition.2013
2.	Title	Radio-Frequency Integrated Circuits and Systems
	Author	HoomanDarabi
	Publisher	Cambridge University Press, First Edition
	Edition	2015
Reference Books		
1.	Title	VLSI for Wireless Communication
	Author	Bosco Leung
	Publisher	Springer, Second Edition
	Edition	2011

Course Contents		
	UNIT I: Introduction to Communication in VLSI: Complexity design and applications - Choice of Technology - Basic concepts in RF Design: Nonlinearly - Time Variance - Intersymbol Interference - random processes - Noise. Definitions of sensitivity - dynamic range -conversion Gain and Distortion. MOSFET behaviour at RF frequencies - Noise performance and limitation of devices - Impedance matching networks - transformers and baluns.	**9**
	UNIT II: Analog& Digital Communication system: Coherent and Non coherent detection - Mobile RF Communication systems and basics of Multiple Access techniques - Receiver and Transmitter Architectures and Testing:	**9**

	Heterodyne - Homodyne, Image-reject, Direct-IF and subsampled receivers - Direct Conversion and two steps transmitters.	
	UNIT III: Low Noise Amplifiers and Mixers: Low Noise Amplifiers: Common Source LNA - Common Gate LNA -Cascode LNA. Mixers: Design of Active and Passive Mixers.	**9**
	UNIT IV: Oscillators : Basic topologies VCO and definition of phase noise. Noise-Power trade-off. Resonatorless VCO design - Quadrature and single-sideband generators - Radio Frequency Synthesizers: PLLs.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 616	Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**MEMORY DEVICES AND CIRCUITS**			
Course Coordinator				
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	acquaint the students with memory cell devices	Understand (Level-II)
CO2	Analyze the read write operation in memory peripherals, novel SRAM cell	Apply (Level-III)
CO3	Analyze the read write operation of DRAM cell	Apply (Level-III)
CO4	Analyze the read/write/hold operations of different memory structures using CAD tools	Analyze (Level-IV)

Semester	**7th**	**Autumn**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names	Digital IC Design				
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Semiconductor Memory Devices and Circuits
	Author	Shimeng Yu
	Publisher	CRC Press
	Edition	1st edition
2.	Title	Memory Devices
	Author	David R. Coelho
	Publisher	Kluwer Academic Publishers, Springer
	Edition	1989
Reference Books		
1.	Title	
	Author	
	Publisher	
	Edition	

Course Contents		
	UNIT I: Overview of volatile memory, Non-volatile memory, On-chip memory, On chip memory types.	**9**
	UNIT II: Review of CMOS circuit design, sensing circuitry basics, Read/write assist circuitry and other peripheral circuitries, Next generation SRAM cell.	**9**
	UNIT III: Introduction to DRAM, High speed DRAM architectures, Open and folded arrays organizations, Bandwidth, latency, and Cycle time, Power, Timing circuits.	**9**
	UNIT IV:	**9**

	STT-MRAM, Data migration policy for hybrid cache. Operation of FLASH memories (FLASH array sensing and programming), Charge Pump circuits. Basic of memory compiler for SRAM architecture using scripting language	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 717	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course
Course Title	**CAD FOR VLSI**
Course Coordinator	
Course Objectives	To educate the learners about use of computer Aided Design for VLSI digital logic families

Course Outcomes		**Cognitive Levels**
CO1	Understand the fundamentals of Computer-Aided Design (CAD) tools for the design, analysis.	Understand (Level-II)
CO2	Analyze with Computer-Aided Design (CAD) to perform synthesis, test and verification.	Analyze (Level-IV)
CO3	Design and analysis of Computer-Aided Design (CAD) tools for the routing and placement of digital Very Large-Scale Integration (VLSI) systems.	Create (Level-VI)
CO4	Create the mini project work with Computer-Aided Design (CAD) tool	Create (Level-VI)

Semester	**7th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books:		
1.	Title	Synthesis and Optimization of Digital Circuits
	Author	G. De Micheli
	Publisher	McGraw Hill
	Edition	1994
2.	Title	Logic Synthesis
	Author	S. A. Devadas, A. Abhijith Ghosh and K. Keutzer
	Publisher	Kluwer Academic
	Edition	1998
Reference Books		
1.	Title	Digital VLSI Chip Design with Cadence and Synopsys CAD Tools
	Author	E. Brunvand
	Publisher	Addison Wesley
	Edition	2010

Course Contents		
	UNIT I: Overview of digital logic design, Simplification of switching functions, K-map-based reduction of switching functions. Combinational logic design, Complex combinational logic modules such as multiplexers/De-multiplexers, decoders, PLAs, and their use in standardized combinational logic design.	**9**
	UNIT II: Memory elements and time delay concepts, Flip-flops, latches, registers; Sequential circuit concepts and state diagrams; Clock-mode sequential circuits analysis and design; Synthesis of state diagrams; Fundamental-mode	**9**

	sequential circuits.	
	UNIT III: Analysis and design, hazards, races, and cycles. Logic element realization: Ideal switch-based implementation; Logic families; FET switches; MOS switch-based logic realization; NMOS and CMOS logic-Pass transistor logic; Algorithmic optimization of combinational logic; VLSI realization of combinational logic.	**9**
	UNIT IV: Language-based description of complex digital systems; RTL descriptions and design language representation; Levels of description; Behavioural and structural descriptions; VHDL and Verilog.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 718	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory course			
Course Title	**THIN FILM CHARACTERIZATION**			
Course Coordinator				
Course Objectives	To educate the learners about the properties, growth techniques and applications of thin films.			

Course Outcomes		**Cognitive Levels**
CO1	To understand the kinetics and growth of thin film.	Understand (Level-II)
CO2	Analyse the growth techniques, measurements and property of thin films	Analyze (Level-IV)
CO3	Analyse the diffusion process in thin films.	Evaluate (Level-VI)
CO4	To characterise the thin film and analyse the coating mechanism	Evaluate (Level-VI)

Semester	**7th**		**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books:		
1.	Title	Materials Science of Thin Films: Deposition and Structure
	Author	M. Ohring
	Publisher	Academic Press
	Edition	2nd Edition, 2001
2.	Title	Thin Film Phenomena
	Author	K. L. Chopra
	Publisher	McGraw-Hill
	Edition	1996
Reference Books		
1.	Title	Handbook of Thin Film Technology
	Author	Maissel and Glange
	Publisher	McGraw Hill
	Edition	1970

Course Contents		
	UNIT I: Need for miniaturization, Basics of thin film, Brief review of kinetic theory of adsorption, desorption, film growth: nucleation and growth kinetics.	**9**
	UNIT II: Growth techniques of thin films: PVD & CVD methods, Thermal evaporation, E-beam evaporation, RF/DC sputtering, Pulsed Laser Deposition, Molecular	**9**

	Beam Epitaxy, Atomic Layer Deposition, spin & dip coating and Chemical vapour deposition. Film thickness measurement, properties of thin films: Structural, optical, electrical and mechanical properties.	
	UNIT III: Thin film analysis (with applications of techniques in solving research problems): ion beam sputtering, depth profiling, Study of inter diffusion in thin films using XPS, AES, SIMS and RBS. Diffraction studies on thin films using XRD and LEED. Thin film morphological studies by SEM, STM and AFM.	**9**
	UNIT IV: Characterization of thin films: Different methods of thickness measurements, electrical, optical, chemical and structural property determination. Some important applications of thin films: Hard and decorative coatings, semiconductor thin films, organic thin films.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 719	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course
Course Title	**MIXED-SIGNAL IC DESIGN**
Course Coordinator	
Course Objectives	To educate the learners about ICs for mixed signal applications

Course Outcomes		**Cognitive Levels**
CO1	Understanding of metal-oxide-semiconductor field-effect transistors and relationship of process technology with models used for analog IC.	Understand (Level-II)
CO2	Analyse the CMOS digital circuits operation.	Analyze (Level-IV)
CO3	Evaluate the complex, non-digital behaviour of the devices and circuits with which digital systems are implemented.	Evaluate (Level-V)
CO4	Explain the circuit design, optimization, and layouts.	Evaluate (Level-V)

Semester	**7th**		**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Analog MOS integrated circuits for signal processing
	Author	R. Gregorian and Temes
	Publisher	Wiely
	Edition	2008
2.	Title	Introduction to CMOS opamps and comparators
	Author	R.Gregorian
	Publisher	Wiely interscience
	Edition	1999

Reference Books

1.	Title	Analog integrated circuit design
	Author	D.Johns and K.Martin
	Publisher	Wiely
	Edition	2008

Course Contents		
	UNIT I: Building blocks for CMOS amplifiers: design of current mirrors, differential amplifiers, CMOS operational trans-conductance amplifiers: design of single ended telescopic cascode, folded cascade and two-stage amplifiers.	**9**
	UNIT II: Frequency compensation schemes: Miller compensation, Ahuja compensation and Nested Miller compensation.	**9**

	UNIT III: Design of fully differential amplifiers, discussion of common mode feedback circuits. Switched capacitor circuits, design of switched capacitor amplifiers and integrators, effect of opamp finite gain, bandwidth and offset, circuit techniques for reducing effects of opamp imperfections, switches and charge injection and clock feed-through effects.	**9**
	UNIT IV: Design of sample and hold and comparators. Fundamentals of data converters; Nyquist rate A/D converters (Flash, interpolating, folding flash, SAR, and pipelined architectures); Nyquist rate D/A converters - voltage, current and charge mode converters, hybrid, and segmented converters); Oversampled A/D and D/A converters. Design of PLL's and DLL's and frequency synthesizers.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 720	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**BIO-MEDICAL ELECTRONICS**			
Course Coordinator				
Course Objectives	To enhance the fundamentals of electronics for bio-medical device related applications			

Course Outcomes		**Cognitive Levels**
CO1	Demonstrate standard tests, measurements, and experiments and to analyse and interpret the result to improve processes.	Understand (Level-II)
CO2	Develop knowledge about different types of Electrodes, Transducers, and Amplifiers.	Apply (Level-III)
CO3	Examine the important and modern methods of imaging techniques.	Analyze (Level-IV)
CO4	Apply the electronics fundamentals for bio-medical application.	Analyze (Level-IV)

Semester	**7th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Handbook of Biomedical Instrumentation
	Author	R.S. Khandpur
	Publisher	Tata McGraw-Hill
	Edition	2nd Edition, 2003.
2.	Title	Introduction to Biomedical Equipment and Technology
	Author	J. Carr Joseph and John M. Brown
	Publisher	Prentice-Hall, New Jersey
	Edition	4th edition. 2001

Reference Books		
1.	Title	3-D Bioprinting Revolution
	Author	Sabrie Soloman
	Publisher	Khanna Publishing House
	Edition	2020

Course Contents		
	UNIT I: Brief introduction to human physiology, Basic components of bio-medical instruments, bioelectric signals, Bio-electrodes. Sensors and Transducers: Signal Acquisition, Transduction, Tactics, and Signal Processing for Improved Sensing, Strain Gauges, Quartz Pressure Sensors, and Matching Sensors to Circuits, Temperature, Capacitive, and Inductive Transducers.	**9**
	UNIT II: Bioelectric Amplifiers: Signal Processing Circuits, Practical Op-Amps, and	**9**

	Isolation Amplifiers Chopper Stabilized Amplifiers, Electrocardiographs: The Heart as a Potential Source, The ECG Waveform, The Standard Lead System, Other ECG Signals, The ECG Preamplifier ECG Readout Devices, ECG Machines, ECG Maintenance and Troubleshooting.	
	UNIT III: Physiological Pressure and Other Cardiovascular Measurements and Devices: Physiological Pressures, Pressure Measurements, Blood Pressure Measurements Oscillo metric, and Ultrasonic Non-invasive Pressure Measurements. Pressure Amplifier Designs, AC Carrier Amplifiers, Systolic, Diastolic, and Mean Detector Circuits, Pressure Differentiation (dP/dT) Circuits, Practical Problems in Pressure Monitoring, Step-Function Frequency Response Test, Defibrillator Circuits, Pacemakers.	**9**
	UNIT IV: Medical Ultrasonography: Ultrasound Transducers, Absorption, and Attenuation of Ultrasound Energy, Biological Effects of Ultrasound, Doppler Effect, Transcutaneous Doppler Flow Detector, Flowmeters, Ultrasonic Blood Pressure Measurement.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 721	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**RF MICROELECTRONICS**			
Course Coordinator				
Course Objectives	To gain the knowledge towards the application of electronic devices in rado frequency range.			

Course Outcomes		**Cognitive Levels**
CO1	Interpret RF frequency response of MOSFET.	Understand (Level-II)
CO2	Construct the RF technology and basic concepts in RF design.	Apply (Level-III)
CO3	Analyse communication concepts in transceiver architectures.	Analyze (Level-IV)
CO4	Evaluate basic blocks in RF systems such as LNA, Mixer and VCO.	Evaluate (Level-V)

Semester	**7th**		**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Radio Frequency Integrated Circuit Design
	Author	John W. M. Rogers, Calvin Plett
	Publisher	Artech House
	Edition	2010
2.	Title	Operation and Modelling of MOS Transistor
	Author	Yannis Tsividis, Colin McAndrew
	Publisher	Oxford University Press
	Edition	3rd edition, 2011
Reference Books		
1.	Title	RF Microelectronics
	Author	Behzad Razavi
	Publisher	Prentice Hall
	Edition	2nd edition, 2011

Course Contents	**UNIT I:** Derivation and estimation of MOS capacitor, MOS capacitor in cutoff, linear and saturation region, derivation and estimation of MOSFET's long-channel model including threshold voltage, body effect, transconductance (g_m), output conductance (g_{ds}), small-signal output resistance (r_o), A Medium-Frequency Small-Signal Model for the Intrinsic Part, Intrinsic Transition Frequency, Noise	**9**

	in MOSFET: white noise, flicker noise, High frequency Small Signal Model, Transition Frequency (f_T) and Maximum oscillation (f_{max}) of MOSFET.	
	UNIT II: Introduction to RF and Wireless Technology: Challenges in RF Design, Complexity Comparison, Design Bottleneck, Applications, Choice of Technology; Basic concepts in RF Design: Units in RF Design, Time Variance, Nonlinearity, Effects of nonlinearity; Noise as Random Process, effect of transfer function on noise, device Noise, Representation of Noise in Circuits. Sensitivity and Dynamic Range.	**9**
	UNIT III: Analog modulation, Digital modulation, Spectral Regrowth, Mobile RF Communications, Multiple Access techniques Wireless standards; Receiver Architectures: Basic Heterodyne Receivers, Modern Heterodyne Receivers, Direct-Conversion Receivers, Image Reject Receivers, Low-IF Receivers; Transmitter Architectures: Direct-Conversion Transmitters, Modern Direct-Conversion Transmitters, Heterodyne Transmitters.	**9**
	UNIT IV: Low Noise Amplifier Design in various technologies, Design of Mixers at GHz frequency range; Various Mixers, their working and implementations; Oscillators: Basic topologies of VCO and definition of phase noise. Noise Power tradeoff. Resonator less VCO design; Quadrature and single-sideband generators.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 722	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**HIGH SPEED INTERFACING CIRCUITS**			
Course Coordinator				
Course Objectives	To gain the knowledge of dynamic CMOS circuits for high-speed interfacing			

Course Outcomes		**Cognitive Levels**
CO1	Understand the basic features and needs for clocking styles	Understand (Level-II)
CO2	Develop a good understanding in the advanced clock logic styles and its applications	Apply (Level-III)
CO3	Develop a good proficiency in the different non-clocking logic styles	Apply (Level-III)
CO4	Evaluate the working of different latching strategies	Evaluate (Level-V)

Semester	**7th**	**Autumn**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	High Speed CMOS Design Styles
	Author	Kerry Bernstein, Keith M. Carrig
	Publisher	Kluwer Academic Publishers
	Edition	2002
2.	Title	Logical Efforts, Designing Fast CMOS Circuits
	Author	Evan Sutherland, Bob Stroll, David Harris
	Publisher	Kluwer Academic Publishers
	Edition	1999
Reference Books		
1.	Title	Skew Tolerant Domino Design
	Author	David Harris
	Publisher	IEEE Journal of Solid- State Circuits
	Edition	2001

Course Contents		
	UNIT I: Single rail domino logic styles, Domino CMOS, Multiple output domino logic, compound domino logic, NORA logic, Dual-Rail domino structures, Differential domino, cross-coupled domino, Modified dual-rail domino logic	**9**
	UNIT II: Latched domino structures, sample-set differential logic, Enable/disable CMOS differential logic, Latch domino, Differential current switch logic,	**9**

	switched output differential structure, clocked pass-gate logic, dynamic complementary pass gate logic.	
	UNIT III: Static combinational CMOS logic, pulsed static logic, Differential cascode voltage switch logic, Differential split-level logic, cascode non-threshold logic, CMOS pass gate & transmission gate logic, DCVS logic with pass gate, complementary pass gate logic	**9**
	UNIT IV: Basic Latch design, storage elements, static and dynamic latches, latch clocking, pseudo-inverter latch, True single-phase clocking, Double edge triggered flip-flops, DCVS latches, static RAM latches, Race free latches for pre-charged logic, cross-coupled differential output	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 723	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course
Course Title	**DIGITAL IMAGE PROCESSING**
Course Coordinator	
Course Objectives	To gain the knowledge of different transforms, segmentation and compression of images signals for digital application.

Course Outcomes		**Cognitive Levels**
CO1	Analyze images in the frequency domain using various transforms.	Analyze (Level-IV)
CO2	Evaluate the techniques for image enhancement and image restoration.	Evaluate (Level-V)
CO3	Categorize various compression techniques.	Analyze (Level-IV)
CO4	Interpret Image compression standards, segmentation and representation techniques.	Evaluate (Level-V)

Semester	**7th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Digital Image Processing
	Author	R. C. Gonzalez and R. E. Woods
	Publisher	Pearson Education
	Edition	Third edition, 2009
2.	Title	Fundamental of Digital Image Processing
	Author	Anil K Jain
	Publisher	Prentice Hall
	Edition	1989

Reference Books		
1.	Title	The essential guide to image processing
	Author	A. C. Bovik
	Publisher	Academic Press
	Edition	Second edition 2009

Course Contents	**UNIT I:** Introduction to digital image processing: What is image processing, Different types of images, Visual perception, Image sensing and Acquisition, Quantization, Sampling, colour image processing, Revision of Mathematical concepts for image processing, Intensity transformation, Filtering in spatial and Frequency domain: Image negatives, Log transformations, Histogram processing, Spatial filter: smoothing and Sharpening, Discrete Fourier transform, properties of 2-D DFT, Image smoothing and Sharpening in Fourier domain	**9**

	UNIT II: Image transforms: Two-dimensional orthogonal and Unitary transforms, Optimum transform, Properties of Unitary transforms, 2D DFT, Cosine transforms, Hadamard transforms, KL transforms, Comparison of image transforms, Edge detection: Gradient and Laplacian based edge detection, Diffusion based edge detection: Isotropic and anisotropic diffusion.	**9**
	UNIT III: Wavelet transform for Image Processing: Multi resolution expansion, Wavelet functions, Wavelet Series expansion, Continuous and Discrete Wavelet transforms, Wavelet transforms for two dimensional signals (images), Applications of wavelet transforms for edge extraction, noise suppression.	**9**
	UNIT IV: Image segmentation: Thresholding, region-based Morphological Watersheds, Bayesian-base image segmentation. Image restoration and reconstruction: Models of image degradation, noise models, Spatial and Frequency domain-based approaches for image restoration, Inverse filtering, Wiener Filtering, Bayesian denoising. Image Compression: Spatial and Temporal redundancy, Basic image compression models, compression standards, basic compression methods: Huffman coding, Run-length coding, Block transform coding, Predictive coding. Colour Image Processing: Colour Fundamentals, Colour Models, Colour transformation, smoothing, sharpening and edge detection in colour images.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 724	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**FLEXIBLE ELECTRONICS**			
Course Coordinator				
Course Objectives	To enhance the knowledge of electronic devices with flexible structure and applications			

Course Outcomes		**Cognitive Levels**
CO1	Summarize the advantages, drawbacks, performances, complementarity, and uniqueness of large area manufacturing vs. silicon technology.	Understand (Level-II)
CO2	Develop the operation principles, architectures, and processing of main devices and systems fabricated for flexible electronics.	Apply (Level-III)
CO3	Analyse the concept of thin film electronics	Analyze (Level-IV)
CO4	Elaborate systems integration issues and propose methods for integration and encapsulation of printed devices and systems.	Create (Level-VI)

Semester	**7th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

Text Books		
1.	Title	Organic and Printed Electronics: Fundamentals and Applications
	Author	G. Nisato, D. Lupo, S. Ganz
	Publisher	CRC Press
	Edition	2006
2.	Title	Handbook of Flexible and Stretchable Electronics
	Author	M. M. Hussain and N. El-Atab
	Publisher	CRC Press
	Edition	2020
Reference Books		
1.	Title	3D Bioprinting Revolution
	Author	Sabrie Soloman
	Publisher	Khanna Publishing House
	Edition	2020

Course Contents		
	UNIT I: Introduction to Flexible and Printed Electronics: Evolution of Flexible Electronics, review of cutting-edge research on electronics that can be flexible, plastic, stretchable, conformable or printed. Electronic materials, components, and systems, applications for IoT.	**9**
	UNIT II: Materials, Processing, and Manufacturing: Various semiconductors, dielectric, and conducting materials, Organic semiconductors, from chemical bonds to bands, Charge injection and transport, Examples of printable functional	**9**

	materials, Thin-film Deposition and Processing Methods for Flexible Devices, Solution-based Patterning Processes; Ink-jet printing, gravure, and other processes, surface energy effects, multilayer patterning.	
	UNIT III: Flexible Thin-Film Transistors and Circuits: Thin-Film Transistor; Device structure and performance, Electrical characteristics, parameter extraction, characterization methods for rigid and flexible devices, electrical stability, printed transistors; organic/polymer, metal-oxide, electrolyte gated, Case studies; sub micrometer OTFTs and gravure printed OTFTs, From transistors to circuits.	**9**
	UNIT IV: Circuits on flexible and non-silicon substrates, Contacts, and Interfaces to Organic and Inorganic Electronic Devices: Schottky contacts, defects, carrier recombination, the effect of applied mechanical strain. Other Flexible Devices and System Integration: Organic Light Emitting Diodes, Organic Solar Cells, thin flexible OLED displays, OLED lighting, smart wallpaper, sensors, logic, and memory, RFID tags, Latest applications of printed electronics, Encapsulation, Roll to roll printing processes, Integration Issues, and Designs for the Future.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 725	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	**QUANTUM COMPUTING**			
Course Coordinator				
Course Objectives	To enhance the fundamentals of quantum computing techniques in current and future technologies			

Course Outcomes		**Cognitive Levels**
CO1	Demonstrate the framework of quantum computation.	Understand (Level-II)
CO2	Utilize the framework to look how that may be useful for future quantum technologies.	Apply (Level-III)
CO3	Analyse the basics of quantum computing.	Analyze (Level-IV)
CO4	Apply the quantum circuits for error control.	Apply (Level-III)

Semester	**7th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Quantum Computation and Quantum Information
	Author	M. A. Nielsen and I. L. Chuang
	Publisher	Cambridge University Press
	Edition	10th, 2010
2.	Title	Quantum Information and Computation
	Author	J. Preskill
	Publisher	CIT Lecture Notes
	Edition	1998

Reference Books		
1.	Title	Quantum Theory: Concepts and Methods
	Author	Asher Peres
	Publisher	Kluwer Academic Publishers
	Edition	1993

Course Contents		
	UNIT I: Review of Quantum Mechanics and Motivation for Quantum Computation Qubit: The qubit state - matrix and Bloch sphere representation - computational basis unitary evolution.	**9**
	UNIT II: Multi-qubit states - No-cloning theorem - Superdense coding - Pure states to Bell states – Bell inequalities. Protocols with multi-qubits: Swapping - Teleportation - gates: CNOT - Toffoli gate - NAND - FANOUT - Walsh	**9**

	Hadamard. Measurement: Projective operators - General, Projective and POVM measure, Ensemble: Density operators - pure and mixed ensemble - time evolution – post measurement density operator. Composite systems: Partial trace - Reduced density operator - Schmidt decomposition, Purification bipartite entanglement.	
	UNIT III: Quantum computing: Classical computing using qubits - Quantum parallelism - Deutsch's algorithm -Deutsch Josza algorithm.	**9**
	UNIT IV: Quantum circuits: Basic gates - ABC decomposition - Gray codes - Universal gates - Principle of deferred and implicit measurements - Quantum Fourier transform - applications: phase estimation, order finding - factoring, discrete logarithm and hidden subgroup problems - Role of prime factoring in classical cryptography – search algorithms. Quantum error correcting codes, Physical realization of qubits.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 726	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	Y

Type of Course	Theory Course
Course Title	**SOLAR CELL TECHNOLOGY**
Course Coordinator	
Course Objectives	To enhance the fundamentals of working of photovoltaic modules, their characteristics and fabrications technologies

Course Outcomes		**Cognitive Levels**
CO1	Understand the principles and arrangements of silicon atoms and p-n junction for illumination	Understand (Level-II)
CO2	Apply knowledge on solar cell parameters for efficient design	Apply (Level-III)
CO3	Analyse the growth process of metallurgical and electronic grade silicon	Analyze (Level-IV)
CO4	Develop the knowledge of solar cell technology for development of commercial solar cell	Create (Level-VI)

Semester	**7th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Solar Photovoltaic Technology and Systems
	Author	Chetan Singh Solanki
	Publisher	Prentice Hall India Learning Private Limited
	Edition	2013
2.	Title	Handbook of Solar Energy: Theory, Analysis and Applications
	Author	G. N. Tiwari, Arvind Tiwari, Shyam
	Publisher	Springer
	Edition	1st edition, 2016.

Reference Books		
1.	Title	SOLAR ENERGY
	Author	S. P. Sukhatme
	Publisher	McGraw hill education
	Edition	4rth edition, 2017

Course Contents	**UNIT I:** Semiconductor as solar cell materials; arrangement of atoms in space: types of unit cells and lattices in solar cell; arrangement of electrons in atom: Bohr model of Hydrogen atom, quantum mechanism, electronic arrangement of silicon atom; Formation of energy bands: energy band model, direct and indirect bandgap; why P-N junction diode?, equilibrium conditions: carrier movement, current densities and carrier concentration profiles; P-N junction in non-equilibrium: I-V relation quantitative analysis; P-N junction under illumination: solar cell: generation of photovoltaics, light generated current, I-V equation of solar cell, solar cell characteristics.	**9**

	UNIT II: Upper limits of cell parameters: short circuit current, open circuit voltage, Fill Factor, Efficiency; Losses in solar cell: model of a solar cell, effect of series and shunt resistance on efficiency, effect of solar radiation in efficiency, effect of temperature in efficiency; sola cell designs; Design of high Isc: requirement of high Isc, choice of junction depth and its orientation, minimization of optical losses, minimization of recombination; Design requirement of high Voc; Design of high FF: base resistance, emitter resistance; Analytical Techniques: solar simulators, I-V measurement, quantum efficiency measurement, minority carrier lifetime and diffusion length measurement.	**9**
	UNIT III: Growth of solar PV industry and Si requirements; steps in producing Si wafers, production of metallurgical grade Si (MGS), production of electronic grade Si (EGS): high purity Si containing gases, obtaining solid poly-Si; production of Si wafers: monocrystalline Si ingots- CZ and FZ process; multi-crystalline Si ingots; wafer-dicing: ID and wire sawing; Si sheet, silicon feedstock for solar cell industry.	**9**
	UNIT IV: Development of commercial solar cell: improvement from use of CZ single crystal, diffused junction and anti-reflective coating; improvement from optimized junction, front metal and surface texturing, use of screen printing, multi-crystalline Si and first terrestrial PV modules; process flow of commercial Si cell technology; processes used in solar cell technology: saw damage removal and surface texturing, P-N Junction formation – diffusion process, thin film layer for ARC and surface passivation, metal contacts-pattern defining and deposition; High efficiency solar cell: passivated emitter solar cell, buried contact and rear point contact solar cell, passivated emitter and rear contact.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 727	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	N	N	N	P
Type of Course	Theory Course			
Course Title	**ADHOC SENSOR NETWORKS**			
Course Coordinator				
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	To Understand the Adhoc wireless networks and their Protocols.	Understand (Level-II)
CO2	To Analyse the transport layer and their protocols.	Analyze (Level-IV)
CO3	To Analysis of Wire and wireless sensors networks.	Analyze (Level-IV)
CO4	To Examine the communication and routing Protocol.	Evaluate (Level-V)

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Ad HOC Wireless Networks: Architectures & Protocols
	Author	C Siva Ram Murty & BS Manoj
	Publisher	Pearson Education.
	Edition	2nd Edition
2.	Title	Fundamentals of Mobile and Pervasive Computing
	Author	Adleshein & Gupta
	Publisher	TMH
	Edition	2005
Reference Books		
1.	Title	Protocols and Architectures for Wireless Sensor Networks,
	Author	By Holger Karl
	Publisher	John Wiley & Sons
	Edition	2006

Course Contents	**UNIT I:** AD HOC Wireless: Introduction, Mobile Ad Hoc Networks, Technologies for Ad Hoc Network, Issues in Ad hoc wireless Networks, IEEE 802.11 Architecture and protocols.	**9**

	Protocol for AD HOC Wireless Networks: Issues and classification of MAC protocol, other MAC protocols, Dynamic Source Routing (DBR), Adhoc Distance Vector (AoDV) routing, Routing Protocols, Multicasting Routing issues	
	UNIT II: Transport layer & Security protocols: Issues in designing transport layer protocols, TCP over Ad Hoc Wireless Networks, Network Security Attacks, and Key management.	**9**
	UNIT III: Wire Sensor Networks: Basic Sensor Network Architectural Elements, Applications of Sensor Networks, Comparison with Ad Hoc Wireless Networks, Challenges and Hurdles. Architecture of WSNs Hardware components, Operating systems and execution environments, some examples of sensor nodes, Network Architecture, Sensor networks scenarios, Optimization goals and figures of merit, Design principles for WSNs.	**9**
	UNIT IV: Communication Protocols: Physical Layer and Transceiver design considerations in WSNs, Fundamentals of (wireless) MAC protocol, Address and name management in wireless sensor networks, Localization and positioning Routing protocols: Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless, Routing Strategies in Wireless Sensor Networks, QoS in wireless sensor networks, Coverage and deployment	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 728	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N

Type of Course	Theory Course
Course Title	**FULL CUSTOM DESIGN**
Course Coordinator	
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering

Course Outcomes		**Cognitive Levels**
CO1	Understand efficient Layout design techniques.	Understand (Level-II)
CO2	Absorb the process variations into the layout.	Apply (Level-III)
CO3	Construct guard rings, pad rings suiting mixed signal environment.	Analyze (Level-IV)
CO4	Design layouts minimizing stress effects.	Analyze (Level-IV)

Semester	**7th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	CMOS IC Layout Concepts Methodologies and Tools
	Author	Dan Clein
	Publisher	Newnes
	Edition	2000
2.	Title	The Art of Analog Layout
	Author	Ray Alan Hastings
	Publisher	Prentice Hall
	Edition	2nd Edition, 2006

Reference Books		
1.	Title	
	Author	
	Publisher	
	Edition	

Course Contents		
	UNIT I: **Introduction:** Schematic fundamentals, Layout design, Introduction to CMOS VLSI manufacturing processes, Layers and connectivity, Process design rules Significance of full custom IC design, layout design flows.	**9**
	UNIT II: **Advanced techniques for specialized building blocks**: Standard cell libraries, Pad cells and Laser fuse cells, advanced techniques for building blocks, Power grid Clock signals and Interconnect routing. Interconnect layout design, Special electrical requirements, Layout design techniques to address electrical characteristics.	**9**
	UNIT III:	**9**

	Layout considerations due to process constraints: Large metal via implementations, Step coverage rules, Special design rules, Latch-up and Guard rings, Constructing the pad ring , Minimizing Stress effects.	
	UNIT IV: **Proper layout:** CAD tools for layout, planning tools, Layout generation tools, Support tools. Analog layout concepts.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 729	Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N

Type of Course	Theory Course
Course Title	**ADVANCED SEMICONDUCTOR MANUFACTURING**
Course Coordinator	
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering

Course Outcomes		**Cognitive Levels**
CO1	Comprehensive Knowledge of Advanced Manufacturing Processes	Understand (Level-II)
CO2	In-Depth Understanding of Semiconductor Materials and Equipment, Process Integration Strategies	Apply (Level-III)
CO3	Performance Enhancement and Scaling Down Technologies	Apply (Level-III)
CO4	Reliability Considerations in Semiconductor Manufacturing	Analyze (Level-IV)

Semester	**7th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	Digital IC Design
Equivalent course codes as per proposed course and old course	

Text Books

1.	Title	Semiconductor Microchips and Fabrication: A Practical Guide to Theory and Manufacturing
	Author	Yaguang Lian
	Publisher	John Wiley and Sons Inc.
	Edition	2023
2.	Title	Handbook of VLSI Microlithography
	Author	William Glendinning, William Andrew
	Publisher	
	Edition	2012

Reference Books

1.	Title	Run-to-Run Control in Semiconductor Manufacturing
	Author	James Moyne
	Publisher	CRC Press
	Edition	2018

Course Contents	**UNIT I:** Overview of semiconductor manufacturing and its significance, Historical context and evolution of semiconductor manufacturing technologies., Introduction to advanced processes and equipment.	**9**
	UNIT II: Principles of photolithography in semiconductor manufacturing, Advanced lithography techniques and innovations, In-depth study of etching processes and equipment, Techniques for thin film deposition in semiconductor manufacturing	**9**
	UNIT III:	**9**

	Overview of advanced materials used in semiconductor manufacturing, Operation and optimization of state-of-the-art manufacturing equipment, Strategies for integrating complex manufacturing processes. Case studies: Examining challenges and solutions in process integration	
	UNIT IV: Techniques for enhancing semiconductor device performance, Innovations in scaling down semiconductor technologies, Factors aRecting reliability in semiconductor manufacturing. Quality control and reliability testing procedures.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 730	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N

Type of Course	Theory Course
Course Title	**DATA CONVERTERS**
Course Coordinator	
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering

Course Outcomes		**Cognitive Levels**
CO1	To study the DC biasing conditions and small signal model of various MOS amplifier configurations	Understand (Level-II)
CO2	To understand gm/Id design methodology of various MOS circuits	Apply (Level-III)
CO3	To study the noise modelling and analysis procedure associated with various MOS circuits	Apply (Level-III)
CO4	To study stability conditions and various compensation techniques in OPAMP and negative feedback amplifiers	Analyze (Level-IV)

Semester	**7th**	**Autumn**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	1	0	4	**48**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Analog to Digital Conversion
	Author	Marcel Pelgrom
	Publisher	Springer Verlag
	Edition	2nd Edition, 2013
2.	Title	Understanding Delta-Sigma Data Converters
	Author	Shanthi Pavan, Richard Schreier, Gabor C. Temes
	Publisher	Willey –IEEE Press
	Edition	2nd Edition, 2017

Reference Books		
1.	Title	Data Converters
	Author	Franco Malobreti
	Publisher	Springer Verlag
	Edition	2007

Course Contents		
	UNIT I: Quantization noise, anti-aliasing filters, gain and offset errors, definitions of INL and DNL, SNR, SFDR, ENOB of ADC/DACs, finite duration pulse aperture effects, transistor matching, Bandgap reference design	**12**
	UNIT II: Current Steering DACs, current cell design issues. Properties of MOS Switches, charge injection, bootstrapping, sampling jitter, thermal noise, Quantization noise and nonlinearity effects	**12**
	UNIT III:	**12**

	Comparator architectures, metastability and yield, Clock feed through effects, switched capacitor amplifiers and offset cancellation, SAR, Flash, Pipeline and time interleaved ADC topologies and their CMOS realizations issues. Error correction procedures for ADCs.	
	UNIT IV: Delta sigma modulators, alternative modulator architectures, quantization and noise shaping, decimation filtering, implementation of Delta sigma modulators, delta sigma DACs.	**12**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: PEVL 731	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course			
Course Title	**RECONFIGURABLE COMPUTING SYSTEM AND APPLICATION**			
Course Coordinator				
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	Ability to apply the fundamentals of reconfigurable computing and reconfigurable architectures.	Understand (Level-II)
CO2	Ability to articulate the design issues involved in reconfigurable computing systems with a specific focus on Field Programmable Gate Arrays (FPGAs) both at theoretical and application levels	Apply (Level-III)
CO3	Ability to develop the performance trade-offs involved in designing a reconfigurable computing platform with a specific focus on the architecture of a configurable logic block and the programmable interconnect.	Apply (Level-III)
CO4	Ability to explore the state-of-the-art reconfigurable computing architectures spanning fine grained (look up table-based processing elements) to coarse grained (arithmetic logic unit level processing elements) architectures.	Analyze (Level-IV)

Semester	**7th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	1	0	4	**48**
Prerequisite course codes with course names				
Equivalent course codes as per proposed course and old course				

Text Books		
1.	Title	Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation
	Author	Scott Hauck and Andre` DeHon
	Publisher	Morgan Kaufmann
	Edition	July 2010
2.	Title	Field – programmable Gate Array Technology
	Author	Stephen M. Trimberger
	Publisher	Springer
	Edition	2007

Reference Books		
1.	Title	The Design Warrior's Guide to FPGAs: Devices, Tools and Flows
	Author	Clive Maxfield
	Publisher	Newnes, Elsevier
	Edition	2006

Course Contents		
	UNIT I: Introduction to Reconfigurable Computing Systems Evolution and Characteristics of Reconfigurable Systems Advantages and Challenges in Reconfigurable Computing	**12**
	UNIT II:	**12**

	Compute Models and System Architectures FPGA Programming with Verilog HDL Compiling C for FPGA Streaming FPGA Applications using Simulink Block Diagrams Operating System Support for Reconfigurable Computing	
	UNIT III: Technology Mapping-FPGA Design Optimization Strategies-Datapath Composition Circuit Layout Specification on FPGAs-Path Finder: Performance-driven FPGA Routing-Retiming and Re-pipelining Techniques-Configuration Bitstream Generation-Fast Compilation Techniques	**12**
	UNIT IV: Implementing Applications with FPGAs-Precision Analysis for Fixed-point Computation-Distributed Arithmetic-CORDIC Architectures for FPGA Computing-Hardware/Software Partitioning, SPIHT Image Compression-Automatic Target Recognition Systems-Multi-FPGA Systems: Logic Emulation-Floating Point Considerations-Network Packet Processing-Memory-centric Computation (Active Pages)	**12**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Open Elective courses

Course Code: OEVL 601	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course			
Course Title	**GROWTH, FABRICATION AND MANUFACTURING OF ELECTRONIC DEVICES**			
Course Coordinator				
Course Objectives	To provide rigorous foundation in MOS and CMOS fabrication process.			

Course Outcomes		**Cognitive Levels**
CO1	To Understand the characterization techniques and design flow of IC technology.	Understand (Level-II)
CO2	To Analyse the monolithic fabrication techniques and monolithic components in different transistors.	Analyze (Level-IV)
CO3	To Examine the Assembly and packaging of the VLSI Devices.	Apply (Level-III)
CO4	Explore the modern processing techniques in VLSI device fabrication.	Evaluate (Level-V)

Semester	**6th**	**Spring**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books :		
1.	Title	VLSI Technology
	Author	S.M. Sze
	Publisher	Tata McGraw Hill
	Edition	1983
2.	Title	Introduction to VLSI
	Author	Eshraghian & Pucknell
	Publisher	Tata McGraw-Hill
	Edition	2007
Reference Books		
1.	Title	VLSI Fabrication Principles
	Author	S.K. Gandhi
	Publisher	Wiley-Blackwell
	Edition	2nd Edition 1994.

Course Contents		
	UNIT I: Miniaturization & its impact on characterization of Electronic Systems: Introduction, Trends & Projections in IC Design & Technology. Comparison between semiconductor materials. Basics of Thick and thin Film Hybrid Technology and monolithic chips. Advantages, limitations & Classification of ICs. Bipolar & MOS Techniques: Flow chart of Bipolar, NMOS and CMOS technologies. Basics of VLSI Design & Process Simulation, SUPREM.	**9**
	UNIT II:	**9**

	Monolithic Techniques: Silicon Refining for EGS, Single Silicon Wafer Preparation & Crystal Defects, Epitaxial Process, Diffusion, Ficks' Laws, Oxidation, Ion-Implantation, Photolithography, Basics of Vacuum Deposition & CVD, Etching techniques, Plasma Etching, Metallization and Isolation Techniques. Monolithic Components: Diodes and Transistors, JFETs, MOSFETs, Resistors, Capacitors, MESFETs, Basics of VLSI CMOS technology, Reliability issues in CMOS VLSI, Latching, and Electromigration.	
	UNIT III: Assembly Techniques & Packaging of VLSI Devices: Introduction to packaging, Package design considerations, VLSI Assembly techniques, Packaging fabrication technology. Surface Mount Technology (SMT): Through hole technology, Surface Mount Technology, applications & SM Components.	**9**
	UNIT IV: Special Techniques for Modern Processes: Self-aligned silicides, hallow junction formation, nitride oxides etc. process flows for CMOS and bipolar IC processes.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: OEVL 602	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N

Type of Course	Theory Course
Course Title	**ELECTRONIC MATERIALS**
Course Coordinator	
Course Objectives	To build the fundamentals for advanced electronic device materials and applications for modern VLSI Device and circuits.

Course Outcomes		**Cognitive Levels**
CO1	Understand the synthesis and properties of nanomaterials.	Understand (Level-II)
CO2	Analyse modelling of composite materials by finite element analysis.	Analyze (Level-IV)
CO3	Differentiate superconducting materials.	Apply (Level-III)
CO4	Understand the characteristics and uses of functional materials.	Understand (Level-II)

Semester	**6th**	**Spring**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Nano: The Essentials
	Author	T.Pradeep
	Publisher	TaTa McGraw-Hill
	Edition	2008
2.	Title	Textbook of Nano science and Nanotechnology
	Author	B.S. Murthy et al.
	Publisher	University press
	Edition	2010
Reference Books		
1.	Title	Composite Materials
	Author	Krishan K Chawla
	Publisher	Springer
	Edition	2nd Ed., 2006

Course Contents	**UNIT I:** Nano Materials: Origin of nano technology, Classification of nano materials, Physical, chemical, electrical, mechanical properties of nano materials. Preparation of nano materials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nano tubes (CNT). Synthesis, preparation of nanotubes, nano sensors, Quantum dots, nano wires, nano biology, nano medicines.	**9**

	UNIT II: Composites: General characteristics of composites, composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modelling, finite element analysis and design.	**9**
	UNIT III: Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo emissive, photovoltaic cells, charge coupled devices (CCD), laser materials.	**9**
	UNIT IV: Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: OEVL 603	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course			
Course Title	**BASICS OF IC DESIGN**			
Course Coordinator				
Course Objectives	To educate the learners about basic of integrated circuits and their application			

Course Outcomes		**Cognitive Levels**
CO1	To understand the MOSFET operation their internal characteristics.	Understand (Level-II)
CO2	To study amplifiers and their classifications.	Apply (Level-III)
CO3	To analyse CMOS circuits and application in memory design	Understand (Level-II)
CO4	To enhance knowledge in DRAM Cell.	Analyze (Level-IV)

Semester	**6th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Design of Analog CMOS Integrated Circuits
	Author	Behzad Razavi
	Publisher	McGraw Hill Education
	Edition	2000
2.	Title	CMOS Analog Circuit Design
	Author	Phillip Allen and Douglas R. Holberg
	Publisher	OUP USA
	Edition	3rd Edition, 2011
3.	Title	Semiconductor Memory Devices and Circuits
	Author	Shimeng Yu
	Publisher	CRC Press
	Edition	1st edition
4.	Title	Memory Devices
	Author	David R. Coelho
	Publisher	Kluwer Academic Publishers, Springer
	Edition	1989
Reference Books		
1.	Title	Operation and Modelling of the MOS Transistor
	Author	Yannis Tsividis
	Publisher	Oxford University Press
	Edition	2ndedition, 2003

Course Contents	**UNIT I:** Introduction to MOSFETS, Simple MOSFET circuits, Threshold voltage model, Capacitance model, MOSFET basics, Device Structure and Operation, General	**9**

	Considerations, MOS I/V Characteristics, Finite Output Resistance in Saturation, Transconductance, Second Order effects: body effect, Channel length modulation, Subthreshold conduction, MOS small signal models, SPICE, Short Channel Effects: DIBL, velocity saturation, hot carrier, impact ionization, surface scattering.	
	UNIT II: Amplifiers: Basic concepts, Single Stage Amplifiers: Basic Concepts, Common Source Stage: resistive load, diode connected load, current source load, triode load, source degeneration. Source Follower, Common Gate Stage, Cascode Stage. Folded cascode. Differential Amplifiers: Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell.	**9**
	UNIT III: Basics of CMOS circuit design, sensing circuitry basics, Read/write assist circuitry and other peripheral circuitries, Next generation SRAM cell.	**9**
	UNIT IV: Introduction to DRAM, High speed DRAM architectures, Open and folded arrays organizations, Bandwidth, latency, and Cycle time, Power, Timing circuits.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: OEVL 704	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course			
Course Title	**DATA COMMUNICATION AND NETWORKING**			
Course Coordinator				
Course Objectives	To build fundamental concept of data sharing, networking and protocols and standards. Also, to make able to perform error corrections and build algorithm			

Course Outcomes		**Cognitive Levels**
CO1	Understand the information sharing and flow of data, categories of network, and different topologies.	Understand (Level-II)
CO2	Build the fundamental concepts of signals, modulation scheme and link layer protocols and standards.	Apply (Level-III)
CO3	To Analyse the errors in data communications and their correction, networks classes and devices standards.	Analyze (Level-IV)
CO4	Evaluation of Data links, Networks and Transport Layers ECB providing more focus on Internet and network performance.	Evaluate (Level-V)

Semester	**7th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	Data and Computer Communications
	Author	William Stallings
	Publisher	Pearson
	Edition	10th EDITION
2.	Title	Computer Networks
	Author	AS Tanenbaum, DJ Wetherall
	Publisher	Prentice-Hall
	Edition	5th Edition, 2010

Reference Books		
1.	Title	Data Communication and Network
	Author	Behrouz A. Forouzan
	Publisher	McGraw Hill
	Edition	5th Edition, 2012

Course Contents		
	UNIT I: Data Communication, Networks, Protocols and Standards, Standards Organizations. Line Configuration, Topology, Transmission Modes, Categories of Networks Internet works, history and development of computer networks, Basic Network Architectures: OSI reference model, TCP/IP reference model, and Networks topologies, types of networks (LAN, MAN, WAN, circuit-switched, packet-switched, message switched, extranet, intranet, Internet, wired, wireless)	**9**
	UNIT II: Study of Signals: Analog signals, Composite Signals, Digital Signals, Physical layer: line encoding, block encoding, scrambling, and Different types of	**9**

	transmission media. Data Link Layer services: framing, error control, flow control, medium access control. Error & Flow control mechanisms: stop and wait, Go back N and selective repeat. MAC protocols: Aloha, slotted aloha, CSMA, CSMA/CD, CSMA/CA, polling, token passing, scheduling.	
	UNIT III: Guided Media, Unguided Media, Transmission Impairments, Performance Wavelength, Shannon Capacity, Media Comparison, PSTN , Switching, Local Area Network Technology: Token Ring. Error detection (Parity, CRC), Ethernet, Fast Ethernet, Gigabit Ethernet, Personal Area Network: Bluetooth and Wireless Communications Standard: Wi-Fi (802.11) and WiMAX	**9**
	UNIT IV: Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Super netting, Classless addressing, Network Address Translation. Networks and devices: Network classes, Repeaters, Hub, Bridges, Switches, Routers, Gateways Brouters Routing Algorithms, Distance Vector Routing, Link State Routing, Transport layer: UDP, TCP. Connection establishment and termination, sliding window, flow and congestion control, timers, retransmission, TCP extensions, Queuing theory, Single and multiple server queuing models, Little's formula. Application Layer. Network Application services and protocols including e-mail, www, DNS, SMTP.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: OEVL 705	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course			
Course Title	**MICRO-ELECTRONICS AND VLSI TECHNOLOGY**			
Course Coordinator				
Course Objectives	To educate the learners about the fabrication process and process integration for the IC design and manufacturing and explore the modern techniques.			

Course Outcomes		**Cognitive Levels**
CO1	To Understand the concepts of clean room environment for Fabrication of integrated circuits and concept of cleaning process for silicon and other wafers for IC fabrication.	Understand (Level-II)
CO2	To develop skills for simulating the various fabrication processes.	Apply (Level-III)
CO3	To understand the process integration flow for different IC fabrication technologies.	Understand (Level-II)
CO4	Examine the current developments in VLSI technology.	Analyze (Level-IV)

Semester	**7th**	**Autumn**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	VLSI Technology
	Author	S M Sze
	Publisher	McGrawHill
	Edition	2nd Edition
2.	Title	Modern VLSI Design Systems on Silicon
	Author	Wayne Wolf
	Publisher	Pearson Education Asia
	Edition	2nd Edition
Reference Books		
1.	Title	CMOS Digital Integrated circuits- Analysis and design
	Author	Sung- Mo Kang and Yusuf Leblenici
	Publisher	McGrawHill
	Edition	2nd Edition

Course Contents		
	UNIT I: Clean Room Technology, Clean Room Classifications, Design concepts, Clean Room Installations and Operations, Automation related facility systems, future trends. Wafer Cleaning Technology - Basic Concepts, Wet cleaning, Dry cleaning, Epitaxy, Fundamental Aspects, Conventional silicon epitaxy, low temperature, Epitaxy of silicon, selective epitaxial growth of Si, Characterization of epitaxial films.	**9**
	UNIT II: Process simulation, Introduction, Ion-implantation, Monte Carlo method,	**9**

	Diffusion and Oxidation, two-dimensional LOCOS simulation example, Epitaxy, Epitaxial doping model, Lithography, Optical projection lithography, Electron-beam lithography, Etching and deposition, future trends.	
	UNIT III: Transistors and layouts - Transistors, Wires and Vias, Design Rules, Layout Design and Stick Diagrams - example, Logic Gate – Pseudo NMOS, DCVS, Domino. Delay through Resistive Interconnect. CMOS Inverter: Basic Circuit and DC Operation – DC Characteristics.	**9**
	UNIT IV: Inverter Switching Characteristics- Static behavior– Switching threshold, Noise Margin, CMOS Inverter Dynamic Behavior- capacitances, propagation delay - High-to-Low time, Low to High time, Sources of Power Consumption, Power Consumption Static and dynamic. Logic Gate - Switch Logic.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: OEVL 706	Open Elective Course: (Y/N)	HM Course: (Y/N)	PC Course: (Y/N)	PE Course: (Y/N)
	Y	N	N	N

Type of Course	Theory Course
Course Title	**EMBEDDED AND REAL TIME OPERATING SYSTEMS**
Course Coordinator	
Course Objectives	To build the concept and understand the working principles of Embedded system with Real Time operating systems and Applications.

Course Outcomes		**Cognitive Levels**
CO1	To Understand the Real-Life applications of Embedded System, Real time operating Systems (RTOS).	Understand (Level-II)
CO2	To Analyze the Task states and scheduling, Task Operations, Semaphores and Message Queues.	Analyze (Level-IV)
CO3	To Analyze the kernel objects in RTOS Services, Timer and Timer Services, I/O Subsystems.	Analyze (Level-IV)
CO4	Evaluate the Memory Management, Synchronization and Communication, Deadlocks	Evaluate (Level-V)

Semester	**6th**	**Spring**

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	**36**

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Real Time Concepts for Embedded Systems
	Author	Qing Li
	Publisher	Elsevier
	Edition	2011
2.	Title	Embedded Systems- Architecture, Programming and Design
	Author	Rajkamal
	Publisher	TMH
	Edition	2007

Reference Books		
1.	Title	Embedded Linux: Hardware, Software and Interfacing
	Author	Dr. Craig Hollabaugh
	Publisher	Addison-Wesley Professional
	Edition	2002

Course Contents		
	UNIT I: Real life examples of Embedded system, Basics of Developing for Embedded system, Embedded system Initialization. Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, Tasks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency.	**9**
	UNIT II: Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use.	**9**
	UNIT III:	**9**

	Other Kernel Objects: Pipes, Event Registers, Signals, Condition Variables, Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem, Port-mapped v/s Memory mapped I/O and DMA, Exceptions and Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations, RT Linux, Micro C/OS-II, Vx Works, Embedded Linux, Tiny OS, and Basic Concepts of Android OS.	
	UNIT IV: Memory management, Dynamic Memory Allocation in Embedded Systems, Fixed size memory management in Embedded systems, Blocking v/s Non-blocking memory functions, Synchronizations and Communications, Resource Classification, Deadlocks Detection and Recovery, Priority Inversions.	**9**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: CSVB 306	Allied Engineering Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	Y	N	N	N
Type of Course	Theory Course and Lab			
Course Title	**DATA STRUCTURE AND PROGRAMMING**			
Course Coordinator				
Course Objectives	This course aims to provide students with a foundation in computer programming. The goals of the course are to develop the basic programming skills in students, and to improve their proficiency in applying the basic knowledge of programming to solve problems related to their field of engineering.			

Course Outcomes		**Cognitive Levels**
CO1	Recognize the need of different data structures and understand their characteristics.	Understand (Level-II)
CO2	Demonstrate the operations for maintaining common data structures and recognize the associated algorithms' complexity.	Understand (Level-II)
CO3	Apply different data structures including stacks, queues, hash tables, binary and general tree structures, search trees, and graphs for given problems.	Apply (Level-III)
CO4	Design, analyse and compare different algorithms for sorting and searching techniques.	Evaluate (Level-V)

Semester	**3rd**	**Autumn**			
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	2	4	**48**
Prerequisite course codes with course names					
Equivalent course codes as per proposed course and old course					

Text Books		
1.	Title	An Introduction to Data Structures with Applications
	Author	Trembley & Sorenson
	Publisher	TMH
	Edition	2/E, 1991
2.	Title	Data Structures using C and C++
	Author	Tanenbaum & Augenstein

	Publisher	Pearson	
	Edition	2/E, 2007	
3.	Title	The C PROGRAMMING LANGUAGE	
	Author	B.W. Kernighan & D.M. Richie	
	Publisher	Prentice Hall	
	Edition	2/E, 1988	
Reference Books			
1.	Title	Fundamentals of Data Structures	
	Author	E. Horowitz and S. Sahni	
	Publisher	Computer Science Press	
	Edition	2nd Edition, 2008	
2.	Title	Let Us C	
	Author	Y. Kanetkar	
	Publisher	Infinity Science Press	
	Edition	13th Edition, 2012	
Course Contents	**UNIT I: INTRODUCTION TO COMPUTER PROGRAMMING AND DATA STRUCTURES** Introduction to programming language, Basics of C, Basic Data types – int, float, double, char, Bool, Void. Arithmetic and logical operators: precedence and associativity. Flow of Control- Conditional statements- If-else, Switch-case constructs, Loops- While, do-while, for. Definition, Characteristics, Creation and manipulation of data structures, Operations on data structures, Types of data structures. Introduction to algorithms, Asymptotic notations, Analysis of algorithms, Time and Space complexity.		**08**
	UNIT II: ARRAY AND LINKED LISTS Arrays, Dynamic memory allocation, one-dimensional array, multi-dimensional array, types of arrays, operations on arrays, row major representation, column major representation, Searching Methods, Linear Search, Binary Search. LINEAR LISTS, Sequential and Linked Representations of Linear Lists, Comparison of Insertion, Deletion and Search Operations for Sequential and Linked Lists, Doubly Linked Lists, Circular Lists, Applications of Lists.		**08**
	UNIT III: STACKS AND QUEUES STACKS: Sequential and Linked Implementations, Representative Applications such as Recursion: Tail Recursion, non-tail recursion, nested recursion, indirect recursion, Expression Evaluation Viz., Infix, Prefix and Postfix, Parenthesis Matching, Towers of Hanoi. QUEUES: Implementation of Queues-array and linked list, Operations of Queues, Circular Queue, Priority Queue, Dequeue, Applications of Queues.		**08**

	UNIT IV: GRAPHS AND TREES GRAPHS: Definition, Terminology, Directed and Undirected Graphs, Properties, Connectivity in Graphs, Applications, Adjacency Matrix and Linked Adjacency Chains, Graph Traversal, Breadth First and Depth First Traversal, Spanning Trees, Shortest Path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths. TREES: Binary Trees and Their Properties, Terminology, Sequential and Linked Implementations, Tree Traversal Methods and Algorithms, Complete Binary Trees, General Trees, Binary Search Trees, AVL Trees, Threaded Trees, Heaps, Heap Implementation, Insertion and Deletion Operations, Heapsort. MULTIWAY TREES: M-Way Search Trees, B Trees, Search, Insert and Delete Operations, Height of B-Tree, 2-3 Trees.	**08**
	UNIT V: SORTING SORTING: Sorting Methods, Bubble Sort, Selection Sort, Quick Sort, Radix Sort, Bucket Sort, Dictionaries, Hashing, Analysis of Collision Resolution Techniques, Character Strings and Different String Operations. Algorithm design techniques: Greedy programming, Dynamic programming	**08**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	
Tentative List of Experiments	To be displayed at the beginning of the semester by the concerned course In-Charge. ● Introduction to Programming Logic Building ● Basic Concepts of a Computer Programming Language ● Implementation of sequential constructs ● Implementation of selection constructs ● Implementation of Iterative constructs ● Implementation of functions (normal functions, recursive functions and parameter passing methods) ● Implementation of Array and its applications ● Implementation of Stack and its applications ● Implementation of Queue and its applications ● Implementation of Link List and its applications ● Implementation of Trees and its applications ● Implementation of Graph and its applications	