Scheme and Syllabus

of

B. Tech. VLSI Design and Technology

(2025-2026 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)

*As per the recommendation of Honourable Senate in it's 19TH Senate meeting held on 10.07.2025

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.

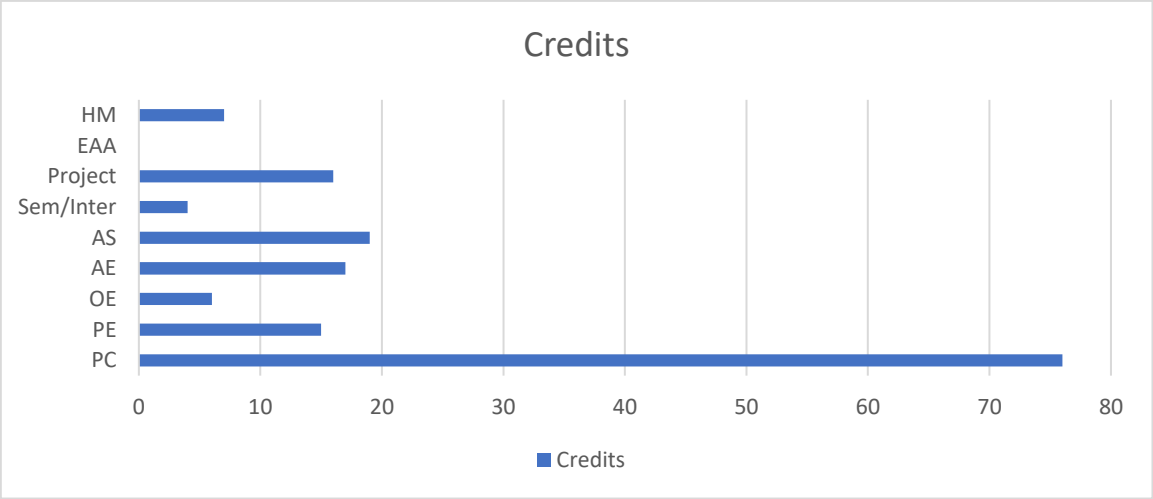
2.6 Program Specific Objectives (PSOs)

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.

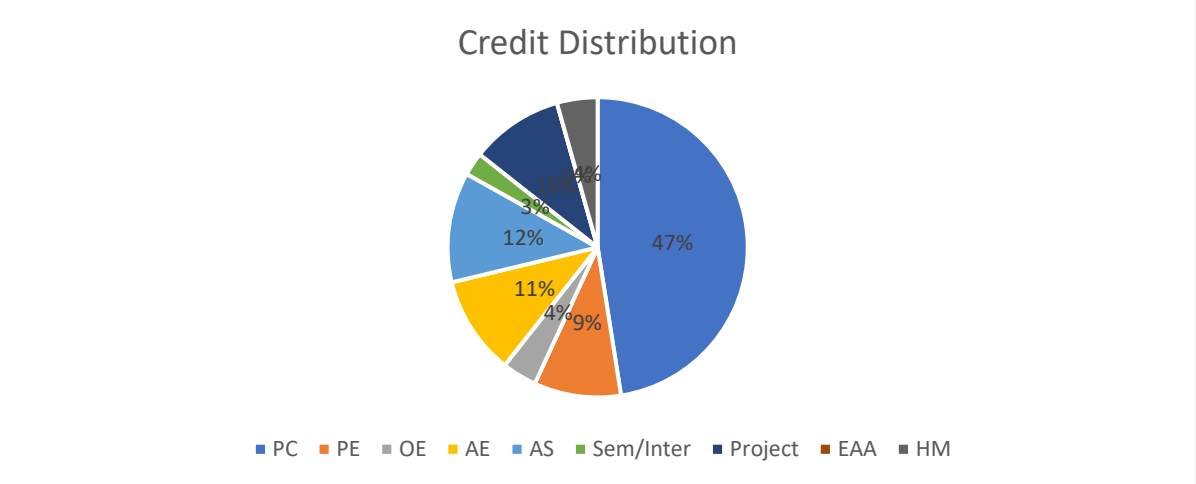
3.1 Semester-wise Credit Structure

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 150	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 Course - 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
4.	OEVL 604	Standardization and Quality Ecosystem	3	0	0	3

Open Elective Course - 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

roposed 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 Title:	**MATHEMATICS I**
Course Code:	**MAVL 101**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**NIL**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the theory and methods of Differential, Integral and Vector Calculus	Understanding (Level-II)
CO-2	Apply different methods for solving problems in Differential, Integral and Vector Calculus	Applying (Level-III)
CO-3	Analyze sequence and series for its convergence. Analyse function for continuity and differentiability. Analyse curves and surfaces for concavity, inflection points, maxima and minima.	Analyzing (Level-IV)
CO-4	Evaluate extreme points for function of several variables. Evaluate limits. Evaluate limit of sequences and sum of some convergent series. Evaluate multiple integrals in rectangular, polar, cylindrical, and spherical coordinates.	Evaluating (Level-V)
CO-5	Create power series. Formulate problems on maxima and minima. Combine vector differential calculus and vector integral calculus. Construct counter- examples for theorems and arguments. Formulate problems on integral and vector calculus.	Creating (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO-2	**2**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO-3	**2**	**3**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO-4	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**
CO-5	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L'Hospital's rule.	**9**
Module-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**
Module-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**
Module-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**

Learning Resources:

Textbooks:	1. Title: Thomas' Calculus, Author: G. Thomas, M. Weir, J. Hass Publisher: Pearson Pub. 2. Advanced Engineering Mathematics. Reena Garg, Khanna Book Publishing Company
Reference Books:	Calculus and Analytic geometry G.B. Thomas and R.L. Finney Publisher : Pearson
Other Suggested Readings:	

Course Title:	**ENGINEERING CHEMISTRY**
Course Code:	**CYVB 102**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand chemical bonding in the molecules and complexes.	Understand (Level-II)
CO-2	To analyze the ranges of the electromagnetic radiation used for exciting different molecular energy levels in various spectroscopic techniques.	Analyze (Level-IV)
CO-3	To understand thermodynamic and electrochemical concepts.	Analyze (Level-IV)
CO-4	To understand periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.	Apply (Level-III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	-	-	1	1	-	-	-	-	2	1	1
CO-2	3	2	1		1	1	1	-	-	-	-	3	1	1
CO-3	3	2	1		-	1	1	-	-	-	-	2	1	1
CO-4	3	2	1		-	1	1	-	-	-	-	2	1	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 based on crystal field stabilization energy (CFSE), factor affecting the magnitude of CFSE, application of crystal field theory. Jahn-Teller effect definition and example from d^9 and high spin d^4 systems.	**10**
Module-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**
Module-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**
Module-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.	**10**

Learning Resources:

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

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 Title:	**ENVIRONMENTAL SCIENCES**
Course Code:	**CELB 101**
L-T-P:	**2-0-0**
Credits:	**2**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To gain knowledge about the environment and ecosystem.	Understand (Level-II)
CO-2	To gain knowledge about the conservation of biodiversity and its importance.	Analyze (Level-IV)
CO-3	To educate students about problems of environmental pollution, its impact on human, ecosystem and control measures and understand the issues related to Solid waste.	Understand (Level-II)
CO-4	To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	2	3	2					2	1	1	1
CO-2	2	2	2	2	1	3	3					2	1	1	1
CO-3	3	2	2	2	2	3	3					2	3	2	2
CO-4	3	2	1	1		2	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Multidisciplinary nature of environmental studies: Definition, scope and importance, need for public awareness.	**04**
Module-II	Ecosystem: 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. Biogeochemical cycles.	**08**
Module-III	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. Inida 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.	**08**
Module-IV	Environmental Pollution: Definition, Cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Noise pollution Solid waste, Green House Effect, Global Warming, Climate Change, Ozone Layer Depletion and Photochemical Smog	**12**

Learning Resources: To expose the students to the basics of environmental sciences through multidisciplinary nature of environmental studies, ecosystem, biodiversity and its conservation, environmental pollution, social Issues and the environment.

Text Books:	1. Anubha Kaushik and C. P. Kaushik's —Perspectives in Environmental Studies, New Age International Publishers, 2018. 2. Benny Joseph, Environmental Science and Engineering ',McGraw Hill Education, 2017. 3. Gilbert M. Masters, Introduction to Environmental Engineering and Science ', 2nd edition, Pearson Education, 2004. 4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall, 2011. 5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering; International edition, 2015.
Reference Books:	1. Environment Impact Assessment Guidelines, Notification of Government of India, 2006. 2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.
Other Suggested Readings:	

Course Title:	**ENGINEERING GRAPHICS & DESIGN**
Course Code:	**MEVP 102**
L-T-P:	**1-0-2**
Credits:	**2**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To Understand the concept of Engineering Graphics.	Understand (Level-II)
CO-2	Apply the concept of engineering drawing to draw the various geometrical shapes.	Apply (Level-III)
CO-3	Apply the concepts are given in projections, technical drawing,	Apply (Level-III)
CO-4	Design team project that illustrates Geometry and topology of engineered components using CAD.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	2	3	1	2	-	-	-	-	-	-	1	3	2	2
CO-2	3	2	3	1	1	-	-	-	-	-	-	3	3	2	3
CO-3	1	3	2	2	3	-	-	-	-	-	-	2	2	1	2
CO-4	2	3	3	3	2	-	-	-	-	-	-	3	2	2	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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.	**09**
Module-II	**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.	**09**
Module-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 Solid Conversion of Isometric Views to Orthographic	**09**

	Views and Vice-versa, Conventions; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.	
Module-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.	**09**

Learning Resources:

Text Books:	1. Jain, Pradeep. Engineering Graphics & Design. Khanna Book Publishing. 2. Jain, Maheshwari, Gautam. Engineering Graphics & Design Khanna Book Publishing.
Reference Books:	1. Bhatt, N.D., Panchal, V.M. and Ingle, P.R., 2010. Engineering Drawing. Charotar Publishing House Pvt. Limited.

Course Title:	**BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING**
Course Code:	**EEVB 103**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand basics of semiconductor theory and principle of diode operation.	Understand (Level-II)
CO-2	To study the design and operation of rectifiers and transistor amplifiers.	Apply (Level-III)
CO-3	To study and apply circuit theorems to AC and DC circuits.	Apply (Level-III)
CO-4	Understand and analyses the working principles of electrical machines.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**3**	**1**	**1**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**
CO-2	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**3**	**1**	**-**
CO-3	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**3**	**-**
CO-4	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**3**	**1**	**-**	**1**	**3**	**3**	**-**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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,	**9**

	Emitter resistance bias circuit and self-bias circuit, Bias compensation techniques.	
Module-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**
Module-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**

Learning Resources:

Text Books:	Basic Electrical Engineering, by Ritu Sahdev, Khanna Book Publishing, 2022 edition. Basic Electrical Engineering, by Nagrath I.J. and D. P. Kothari, McGraw-Hill Education, 2001 edition.
Reference Books:	Engineering Circuit Analysis, by Hayt and Kimberly, Tata McGraw Hill, 8th edition 2013
Other Suggested Readings:	Basic Electrical and Electronics Engineering **by** S.K. Bhattacharya **(**pearson 2nd edition**).**

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 Title:	**HUMAN VALUES AND ETHICS**
Course Code:	**HMVB 101**
L-T-P:	**2-0-2**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Develop and understand the basic elements of human values and business ethics at the organizational level and get acquainted with the business world.	Understand (Level-II)
CO-2	Understand the concept of moral autonomy and theories of Moral Development possibly dealing with the moral issues and moral dilemmas at the workplace.	Understand (Level-II)
CO-3	Understand and develop and leverage emotional, spiritual and social intelligence in the workplace.	Apply (Level-III)
CO-4	Understand the conceptual framework of HRP and evaluate practical solutions of problems related to manpower planning in the organization.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	-	-	-	-	-	2	1	2	3	-	-	1	1	-
CO-2	-	-	-	1	-	3	1	3	2	1	1	2	-	-
CO-3	-	-	-	-	-	3	-	3	2	-	1	2	1	1
CO-4	-	-	-	1	1	2	1	3	3	1	3	1	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Organization Behaviour and Personality concepts Introduction: Organization and Organizational Behavior- Concept and significance, Organizational Structures, Individual & Group Behavior; 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.	**09**
Module-II	Concepts of Emotions, feelings, Intelligence, Responsibility and Accountability Feelings, Classification of Feelings; Dimensions of Emotions, Emotions and External Constraints; Emotional Intelligence; Spiritual Intelligence; Authority, Responsibility and Accountability: Meaning of Authority, Responsibility and Accountability, Balance between Authority, Responsibility and Accountability.	**09**
Module- III	Moral development philosophies, Moral Autonomy and Ethical theories.	**09**

	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 Behavior.	
Module-IV	04 Concepts of HR policy, HR Planning and Ethical Decision Making Human Resource Policies & Procedures- Introduction, Importance of Policies, Policy Formation, Human Resources Planning. Decision-making & Ethics	**09**

Learning Resources:		
S No.	**Text Books:**	**Year**
1.	A.K. Chitale, R.P. Mohanty and N.R. Dubey, "Organizational Behaviour: Text and Cases", PHI Learning Private Limited,	2019.
2.	M.W. Martin, R. Schinzinger, "Ethics in Engineering", McGraw-Hill Education,	2005
3	. R.S. Naagarazan, "A Textbook on Professional Ethics and Human Values"	
Reference Books:		
1.	A.Alavudeen, R.KalilRahman and M.Jayakumaran "Professional Ethics and Human Values" - LaxmiPublications.	
2.	Prof.D.R.Kiran "Professional Ethics and Human Values"	

List of Experiments:

1. Management Activities, Self exploratory tasks and psychological Personality tests
2. Case Studies related to Engineering Profession -verbal and videos-based
3. Group Discussion over various organizational challenges and moral dilemmas at workplace
4. Debates on topics of ethics, human values and laws / engineers versus managers at workplace
5. Presentations over code of ethics and other issues.
6. Skits based on problem-solution oriented approach

Course Title:	**TECHNICAL C_MMUNICATION**
Course Code:	**HMVP 102**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand basic grammar principles and sentence construction.	Understand (Level-II)
CO-2	Demonstrate clear and coherent passages and effective letters for job application.	Apply (Level III)
CO-3	Develop technical reports and interpret graphs.	Apply (Level III)
CO-4	Analyze the reading comprehension.	Analyse (Level IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1						**1**			**1**	**3**		**2**		**1**
CO-2						**1**			**1**	**3**		**2**		**1**
CO-3						**1**			**1**	**3**		**2**		**1**
CO-4						**1**			**1**	**3**		**2**		**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Session No.	**Activity Description**
1.	**English Sound System I**: Introduction to vowels, consonants, diphthongs, and phonetic symbols. Dictionary usage for phonetic transcription.
2.	**English Sound System II**: Understanding Received Pronunciation (RP) – its features and relevance. Practice transcription exercises.
3.	**Stress and Intonation I**: Identifying word and sentence stress. Listening and repetition exercises.
4.	**Stress and Intonation II**: Exploring intonation patterns – rising, falling, and mixed. Role-plays using intonation in real-life contexts.
5.	**Introducing Oneself & Role Play I**: Practicing self-introduction in formal and social contexts. Peer interaction and feedback.
6.	**Role Play II – Professional Contexts**: Enacting professional scenarios (e.g., interviews, workplace conversations). Focus on tone, fluency, and etiquette.
7.	**Oral Presentation I – Planning**: Understanding the structure of a presentation. Planning and designing short presentations using visual aids.
8.	**Oral Presentation II – Delivery**: Presenting with a focus on voice modulation, body language, and audience engagement. Peer and instructor feedback.
9.	**Listening Comprehension I**: Listening to general content (dialogues, announcements). Developing active listening and note-taking skills.
10.	**Listening Comprehension II**: Listening to academic/technical content (lectures, podcasts). Comprehension tasks and summary writing.

11.	**Reading Techniques**: Practicing skimming and scanning on academic and general texts. Identifying purpose and extracting key information.
12.	**Reading Comprehension – Technical Texts**: Reading and interpreting technical documents (e.g., patents, manuals). Answering comprehension questions.
13.	**Group Discussion & Debate I**: Introduction to GD rules and strategies. Practicing short group discussions on familiar topics.
14.	**Group Discussion & Debate II**: Conducting structured debates on current or academic topics. Evaluation based on clarity, coherence, and engagement.

Learning Resources:

Text Books:	Anna University. *English for Engineers and Technologists.* Publisher: Orient Blackswan, 1st Edition Ashraf, M. Rizvi. *Effective Technical Communication.* Publisher: Tata McGraw-Hill, 2006
Reference Books:	Meenakshi Raman & Sangeeta Sharma. *Technical Communication: Principles and Practice.* Publisher: Oxford University Press, 2nd Edition, 2011

Semester II

Course Title:	**MATHEMATICS II**
Course Code:	**MAVL 203**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**Mathematics – I (MAVL 101)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the theory and methods of linear algebra, differential equations and complex analysis.	Understanding (Level-II)
CO-2	Apply different methods for solving problems in linear algebra, differential equations and complex analysis.	Applying (Level-III)
CO-3	Analyze the rank of a matrix, linear independence, orthogonal projections, transformations, differential equations, complex functions.	Analyzing (Level-IV)
CO-4	Evaluate inverse, eigenvalues and eigenvector, differential equations, line integrals and integrals using residue theorem.	Evaluating (Level-V)
CO-5	Construct normal form of matrix, orthogonal and orthonormal bases, differential equations, and Taylor and Laurent series.	Creating (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	-	-	-	-	-	-	-	-	1	2	1
CO-2	2	2	2	-	1	-	-	-	-	-	-	1	2	1
CO-3	2	3	1	-	1	-	-	-	-	-	-	1	2	1
CO-4	3	2	2	-	1	-	-	-	-	-	-	1	3	1
CO-5	3	2	1	-	1	-	-	-	-	-	-	1	3	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	First order ordinary differential equations: Exact, linear and Bernoulli's 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.	**9**
Module-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**
Module-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**

Learning Resources:

Text Books:	1. Title: Linear Algebra and its Applications Author: David C. Lay Publisher: Pearson Pub. 2. Title: Complex variables and its applications Author : R. V. Churchill Publisher: McGraw Hill 3. Title Advanced Engineering Mathematics Author E. Kreyszig Publisher John Wiley and Sons
Reference Books:	

Other Suggested Readings:	

Course Title:	**ENGINEERING PHYSICS**
Course Code:	**PHVB 204**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the concepts of Electrostatics in vacuum and dielectric medium.	Understand (Level-II)
CO-2	Analyze the magneto static in linear magnetic medium.	Analyze (Level-IV)
CO-3	Apply the Faraday's law and Maxwell's equation in integral and differential forms.	Apply (Level-III)
CO-4	To understand the concepts of semiconductor physics.	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**3**	**2**	**2**	**1**	**0**	**0**	**2**	**2**	**0**	**1**	**1**	**1**
CO-2	**3**	**2**	**3**	**2**	**2**	**1**	**0**	**0**	**2**	**2**	**0**	**1**	**1**	**1**
CO-3	**3**	**2**	**3**	**2**	**3**	**1**	**0**	**0**	**2**	**2**	**0**	**1**	**1**	**1**
CO-4	**3**	**2**	**3**	**2**	**3**	**2**	**0**	**0**	**2**	**3**	**0**	**1**	**1**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 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	**12**

	in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.	
Module-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**
Module-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**
Module-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**

Learning Resources:

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
Other Suggested Readings:		

List of Experiments:	
1.	Experiments on electromagnetic induction and electromagnetic braking
2.	LC circuit and LCR circuit
3.	Determination of semiconductor bandgap
4.	Determination of Planck's constant using LED
5.	Basic experiments with PN junction diode, Zener diode, and LED
6.	Resonance phenomena in LCR series and parallel circuits
7.	Magnetic field from Helmholtz coil
8.	Measurement of Lorentz force in a vacuum tube

Course Title:	**PROBLEM SOLVING AND COMPUTER PROGRAMMING**
Course Code:	**CSVB 204**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the basics of computer and various Problem solving approaches.	Remembering (Level – I) Understanding (Level – II)
CO-2	Understand the fundamentals of C programming.	Remembering (Level – I) Understanding (Level – II)
CO-3	Apply functions, arrays, and structures for solving problem.	Understanding (Level – II) Applying (Level – III)
CO-4	Understand the use of pointers and file management in C.	Understanding (Level – II) Applying (Level – III)

Course Articulation Matrix:

COs	**POs & PSOs**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												1	
CO2	2	1	1										2	2
CO3	3	2	2	2	2	1							2	2
CO4	3	2	2	2	2	2							2	

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Computers: Hardware and Software. Basic Model of Computation Notion of Algorithms, Flowcharts, Top down design, Bottom-up approaches of problem solving, Number system.	**8**
Module-II	Introduction to programming language, Basics of C, Basic Data types - int, float double, char, Bool, Void. Arithmetic and logical operators: precedence and association. Flow of Control Conditional statements- If-else, Switch-case constructs, Loops- While, do-while, for.	**8**
Module-III	Function - User defined functions, library functions, Parameter passing call by value, call by reference, recursion. Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.	**8**

Module-IV	Arrays- Advantages and drawbacks, One dimensional, Multi-Dimensional Arrays and strings: Declaration, initialization, Accessing, Passing arrays and strings as parameters to functions. Pointers, Dynamic memory allocation, Dynamic arrays- One dimensional, Multidimensional dynamic array.	**8**
Module-V	Structure: Declaration, Initialization, passing structure to function, Use of pointers in structures. Preprocessors, Macros, File management in C 1/0 - Opening closing and| editing files. Correctness & Efficiency Issues in Programming, Time & Space measures.	**4**

Learning Resources:

1. To understand the computational model of Computer.
2. To understand the concepts of C programming.
3. To apply functions of C programming for solving problems.
4. To understand the concept of file management in C.

Text Books:		
1	**Title**	Programming in ANSI C
	Author	E. Balagurusamy
	Publisher	TATA McGraw Hil1
	Edition	6 editions, 2012
Reference Book:		
1	**Title**	Let Us C
	Author	Yashwant Kanetkar
	Publisher	Infinity Science Press
	Edition	13th edition, 2012
2	**Title**	Schaum's Outline of Programming with C
	Author	Byron S Gottfried
	Publisher	TATA McGraw Hill

Exp. No.	List of Experiments
1	Familiarization of Linux environment - How to do Programming in C with Linux.
2	Familiarization of console VO and operators in C. a. Display "Hello World" b. Read two numbers, add them and display their sum c. Read the radius of a circle, calculate its area and display it d. Evaluate the arithmetic expression ((a -b/c *d+ e) * (f +g)) and display solution. Read the values of the variables from the user through console.
3	Write a program to a. Calculate simple and compound interest. b. Find the roots of quadratic equation.
4	Write a program to swap values of two variables with and without using third variable.
5	Write a program to find the largest of three numbers with and without ternary Operators.
6	Write a program to input name, marks of 5 subjects of a student and display the name of the student, the total marks scored, percentage scored and the class of result.
7	Read a Natural Number and check whether the number is a. prime or not b. Armstrong or not C. even or odd.
8	Write a program to compute grade of students using if else adder. The grades are assigned as followed: Marks Grade marks<50 F 50 marks< 60 C 60 marks<70 B 70 marks<80 B+ 80 marks<90 A 90 marks<100 A+
9	Write a program to check whether the entered year is leap year or not (a year is leap if it is divisible by 4 and divisible by 100 or 400).
10	Write a program to find whether a character is consonant or vowel using switch statement.
11	Find the factorial of a given Natural Number n using recursive and non-recursive functions.
12	Compute sum of the elements stored in an array using pointers and user defined function.

Course Title:	**PROBABILITY THEORY AND STOCHASTIC PROCESS**
Course Code:	**MAVL 205**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Mathematics -I (MAVL101)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To acquire the fundamental knowledge in probability concepts	Understand (Level II)
CO-2	To manage situations involving more than one random variable and functions of random variables in engineering applications.	Apply (Level III)
CO-3	Make use of theorems related to random signals	Analyze (Level IV)
CO-4	To Assess the propagation of random signals in LTI systems.	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**1**	**1**			**1**					**1**	**3**	**2**
CO-2	**1**	**3**	**2**	**1**			**1**					**2**	**3**	**2**
CO-3	**1**	**2**	**3**	**1**	**1**		**1**					**2**	**3**	**2**
CO-4	**1**	**1**	**2**	**3**	**1**		**1**					**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.	**09**
Module-II	Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions	**09**
Module-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;	**09**
Module-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.	**09**

Learning Resources:

<table>
<tr><td>Text Books:</td><td>
<table>
<tr><td>Title</td><td>Probability and Random Processes with Applications to Signal Processing</td></tr>
<tr><td>Author</td><td>H. Stark and J. Woods</td></tr>
<tr><td>Publisher</td><td>Pearson Education</td></tr>
<tr><td>Edition</td><td>Third Edition</td></tr>
<tr><td>Title</td><td>Probability, Random Variables and Stochastic Processes</td></tr>
<tr><td>Author</td><td>A.Papoulis and S. Unnikrishnan Pillai</td></tr>
<tr><td>Publisher</td><td>McGraw Hill</td></tr>
<tr><td>Edition</td><td>Fourth Edition</td></tr>
</table>
</td></tr>
<tr><td>Reference Books:</td><td>
<table>
<tr><td>1:Title</td><td>Introduction to Probability Theory with Stochastic Processes</td></tr>
<tr><td>Author</td><td>K. L. Chung</td></tr>
<tr><td>Publisher</td><td>Springer International</td></tr>
<tr><td>Edition</td><td>2012</td></tr>
</table>
</td></tr>
<tr><td>Other Suggested Readings:</td><td>1: Cinlar E. Introduction to stochastic processes. Courier Corporation; 2013 Feb 20.
2: Ghahramani S. Fundamentals of probability: with stochastic processes. Chapman and Hall/CRC; 2018 Sep 5.</td></tr>
</table>

Course Title:	**BASICS OF SEMICONDUCTOR MATERIALS**
Course Code:	**ECVL 201**
L-T-P:	**3-1-0**
Credits:	**4**
Pre-requisites:	**Engineering Physics (PHVB 204)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the formation and properties of semiconductor crystals.	Understand (Level II)
CO-2	To associate the electronic band structure to the properties of semiconductor materials and devices.	Apply (Level III)
CO-3	To analyze carrier dynamics and transport in semiconductors	Analyze (Level IV)
CO-4	To construct energy band diagrams of semiconductor hetero-structures	Evaluate (Level V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**		**2**								**2**	**2**	**1**
CO-2	**3**	**1**		**2**								**2**	**2**	**1**
CO-3	**3**			**2**								**2**	**2**	**1**
CO-4	**3**			**2**								**2**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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, 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.	**9**
Module-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**

Module-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**

Learning Resources:

Text Books:	1. "The Materials Science of Semiconductors" by Angus Rockett, University of Illinois, Urbana, IL, USA, Springer Science, Business Media, LLC, 1st Ed., 2008. [ISBN 978-0-387-25653-5]. 2. "Quantum Physics of Semiconductor Materials and Devices" by Debdeep Jena, Oxford University Press, UK. 1st Edition, May 2022. [ISBN: 9780198856856]
Reference Books:	"Engineering Materials" by Kenneth G. Budinski, Prentice Hall of India, New Delhi, 9th Edition, March 2009. [ISBN: 0137128428]
Other Suggested Readings:	

Course Title:	**HOLISTIC HEALTH AND SPORTS**
Course Code:	**HSPB 151**
L-T-P:	**0-0-2**
Credits:	**1**

1. Course Objectives

The course is designed to:

1. Promote awareness of holistic health, physical fitness, and mental well-being.
2. Introduce students to fundamental principles of Yoga, Athletics, and Sports.
3. Foster development of team spirit, leadership, discipline, and ethical conduct.
4. Enhance self-confidence, stress management skills, and concentration.
5. Encourage a healthy, active lifestyle through lifelong engagement in physical activity.

2. Course Outcomes (COs):

By the end of the course, students will be able to:

CO Code	Course Outcome Description	Cognitive Levels
CO1	Demonstrate improved physical fitness, coordination, and flexibility through yoga and sports activities.	Remember (Level-I)
CO2	Apply yogic practices (asana, pranayama, and meditation) for enhancing mental well-being, concentration, and emotional balance.	Remember (Level-I)
CO3	Exhibit proper techniques and understanding in basic athletic and sports skills.	Apply (Level-III)
CO4	Participate effectively in team and individual sports with leadership, cooperation, and ethical conduct.	Analyze (Level-IV)
CO5	Integrate regular physical activity into a healthy lifestyle and appreciate its lifelong benefits.	

3. Program Outcomes (POs)

Students who complete the **Holistic Health and Sports (HSPB 150)** course will demonstrate the ability to:

1. **PO1 – Awareness of Health & Wellness:** Understand and apply fundamental principles of physical fitness, yoga, and mental well-being in personal and professional life.
2. **PO2 – Holistic Problem Solving:** Use physical and mental strategies (like yoga, breath work, sports tactics) to manage stress, improve focus, and support emotional balance.
3. **PO3 – Performance Design:** Demonstrate the ability to plan and implement fitness routines and sports strategies that enhance personal health and group performance.
4. **PO4 – Analytical Skills in Movement:** Evaluate and improve athletic techniques, body mechanics, and yoga practices through observation and self-assessment.
5. **PO5 – Adaptation of Tools:** Use sports equipment, fitness trackers, or yoga props to optimize training and performance safely and effectively.
6. **PO6 – Societal Contribution:** Recognize the role of physical education and sports in building healthy communities, social inclusion, and national identity.
7. **PO7 – Sustainability in Lifestyle:** Adopt and promote sustainable habits related to health, environment (e.g., eco-friendly sports), and wellness.
8. **PO8 – Ethics & Fair Play:** Demonstrate ethical behavior, integrity, and fair play in all physical activities and competitions.
9. **PO9 – Teamwork and Leadership:** Exhibit collaboration, team coordination, and leadership in group sports and fitness activities.
10. **PO10 – Effective Communication:** Communicate clearly during team play, instruction, and in expressing ideas related to health and sports.
11. **PO11 – Organizational Skills:** Participate in planning sports events or group activities, applying time management and event coordination skills.
12. **PO12 – Lifelong Fitness Learning:** Commit to continuous physical self-improvement and understand the importance of lifelong health and active living.

4. Program Educational Objectives (PEOs)

1. **PEO1 – Practice Holistic Well-being:** Integrate physical activity, mindfulness, and healthy habits into their daily lifestyle for enhanced productivity and personal growth.
2. **PEO2 – Be Health Ambassadors:** Contribute positively to society by promoting awareness about fitness, yoga, and wellness among peers and in the community.
3. **PEO3 – Lead Through Sport:** Demonstrate leadership, resilience, and ethical behavior learned through sports and physical education in professional and academic settings.
4. **PEO4 – Pursue Continuous Self-Improvement:** Remain engaged in lifelong physical and mental self-improvement, exploring various fitness modalities and wellness techniques.
5. **PEO5 – Adapt to a Balanced Life:** Maintain an effective balance between work, study, and recreation through knowledge and habits gained in this course.

5. CO-PO Mapping

COs \ POs	PO1 Health & Wellness	PO2 Problem Solving	PO3 Performance Design	PO4 Movement Analysis	PO5 Tool Usage	PO6 Society	PO7 Sustainability	PO8 Ethics	PO9 Teamwork	PO10 Communication	PO11 Org. Skills	PO12 Lifelong Learning
CO1	✔		✔	✔	✔		✔					✔
CO2	✔	✔		✔			✔	✔				✔
CO3	✔		✔	✔	✔				✔			✔
CO4		✔				✔		✔	✔	✔	✔	✔
CO5	✔					✔	✔	✔				✔

Semester III

Course Title:	**ELECTRONIC DEVICES AND CIRCUITS**
Course Code:	**ECVB 302**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Basics of Electrical and Electronics Engineering (EEVB 103), Engineering Physics (PHVB 204)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	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)
CO-2	Understand the concept of BJT and MOS transistors and their characteristics.	Remember (Level-I)
CO-3	Analysis and applications of BJT and MOS transistors.	Apply (Level-III)
CO-4	Understand the concept of BJT and MOS transistors and their characteristics.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**2**	**3**								**2**	**2**	**2**
CO-2	**2**	**3**	**2**	**3**								**2**	**2**	**2**
CO-3	**2**	**3**	**2**	**3**								**2**	**2**	**2**
CO-4	**2**	**3**	**2**	**3**								**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	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**
Module-II	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**

Module-III	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**
Module-IV	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**

Learning Resources:

Text Books:	1. "Electronic Devices and Circuits" by David A. Bell, Oxford, 5th edition. 2. "Microelectronic Circuits" by Adel S. Sedra & Kenneth C. smith, Oxford, 7th edition.
Reference Books:	1. "Physics of Semiconductor Devices" by S. M. Sze and K. N. Kwok, John Wiley & Sons, 3rd edition, 2006 2. "Solid State Electronic Devices" by G. Streetman, and S. K. Banerjee, Pearson, 7th edition, 2014. 3. "Semiconductor Physics and Devices" by D. Neamen , D. Biswas, McGraw-Hill Education, 2017 4. "Analysis and Design of Analog Integrated Circuits" by Paul Gray, Hurst, Lewis, Meyer, John Willey & Sons, 4th edition. 5. "Electronic Devices and Circuits" F. Bogart Jr. , Pearson, 6th edition.
Other Suggested Readings:	

List of Experiments:	
1.	Forward and Reverse Characteristics of PN Junction Diode.
2.	Zener Diode Characteristics and Zener as Voltage Regulator
3.	Input & Output Characteristics of Transistor in CB Configuration.
4.	Input & Output Characteristics of Transistor in CE Configuration
5.	Half Wave Rectifier with & without Filters
6.	Full Wave Rectifier with & without Filters
7.	FET Characteristics
8.	Design of self-bias circuit
9.	Frequency Response of CC Amplifier
10.	Frequency Response of CE Amplifier
11.	Frequency Response of Common Source FET Amplifier
12.	SCR Characteristics
13.	UJT Characteristics

Course Title:	**SIGNALS AND SYSTEMS**
Course Code:	**ECVB 303**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Mathematics-I (MAVL 101), Mathematics-II (MAVL 203)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO1	Understand the continuous and discrete-time signals and systems, their properties and representations	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)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	3	2	2	2	0	0	0	0	0	0	2	3	2
CO-2	3	3	2	3	2	0	0	0	0	0	0	2	3	2
CO-3	3	3	3	3	2	0	0	0	0	0	0	2	3	2
CO-4	3	3	3	3	3	0	0	0	0	0	0	2	3	2

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 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.	**9**
Module-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,	**9**

	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.	
Module-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**
Module-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**

Learning Resources:

Text Books:		
1.	Title	Signals and Systems
	Author	Alan V. Oppenheim, Alan S. Willsky with S. Hamid Nawab
	Publisher	PHI Publications
2.	Edition	2011
	Title	Principles of Linear Systems and Signals
	Author	B.P. Lathi
3.	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

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 Title:	**DIGITAL ELECTRONICS**
Course Code:	**ECVB 304**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Mathematics-I (MAVL 101)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand digital logic levels and application of knowledge to understand digital electronics circuits.	Understand (Level-II)
CO-2	Understand the concept of digital and binary systems	Understand (Level-II)
CO-3	Design and analyze combinational logic circuits.	Create (Level-VI)
CO-4	Design and analyze sequential logic circuits.	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-2	**2**	**3**	**1**	**2**								**3**	**3**	**2**
CO-3	**2**	**3**	**2**	**2**								**3**	**3**	**2**
CO-4	**2**	**3**	**1**	**2**								**3**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-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	**9**

	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.	
Module-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**

Learning Resources:

Text Books:	J. F. Wakerly, Digital Design, Principles and Practices T.C. Bratee, Digital Computer Fundamentals
Reference Books:	M Morris Mano, Digital Logic & Computer Design
Other Suggested Readings:	

List of Experiments:	
1.	Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates
2.	Construction of half and full adder using XOR and NAND gates and verification of its operation.
3.	To Study and Verify Half and Full Subtractor
4.	Realization of logic functions with the help of Universal Gates (NAND, NOR)
5.	Construction of a NOR gate latch and verification of its operation
6.	Verify the truth table of RS, JK, T and D flip-flops using NAND and NOR gates
7.	Design and verify the 4-Bit Serial In - Parallel Out Shift Registers
8.	Implementation and verification of decoder and encoder using logic gates
9.	Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates
10.	Design and verify the 4- Bit Synchronous or Asynchronous Counter using JK Flip Flop
11.	Verify Binary to Gray and Gray to Binary conversion using NAND gates only
12.	Verify the truth table of one bit and two-bit comparator using logic Gates.

Course Title:	**NETWORK ANALYSIS AND CONTROL THEORY**
Course Code:	EEVL 305
L-T-P:	3-1-0
Credits:	**4**
Pre-requisites:	**Basics of Electrical and Electronics Engineering (EEVB 103)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Apply the knowledge of basic circuital law and simplify the circuit networks.	Apply (Level-III)
CO-2	Analyze the fundamentals of network analysis using matrices, two-port, and network synthesis.	Analyze (Level-IV)
CO-3	To understand the concept of open loop and closed loop control systems.	Analyze (Level-IV)
CO-4	Study time domain analysis and different methods of stability analysis.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO-2	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-3	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO-4	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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	**9**

	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.	
Module-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**
Module-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**

Learning Resources:

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
Other Suggested Readings:	

Course Title:	**DATA STRUCTURE AND PROGRAMMING**
Course Code:	**CSVB 306**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Problem Solving and Computer Programming (CSVB 204)**

Course Outcomes:

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)

Course Articulation Matrix:

	PO -1	**PO-2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO-7**	**PO -8**	**PO -9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	3	2	2	2	0	0	0	0	0	0	2	3	2
CO-2	3	3	3	3	3	0	0	0	0	1	1	2	3	3
CO-3	3	3	3	3	3	0	0	0	0	1	1	2	3	3
CO-4	3	3	3	3	3	0	0	0	0	1	1	2	3	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	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**
Module-II	**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**

Module-III	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**
Module-IV	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**
Module-V	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**

Learning Resources:

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

List of Experiments:

Experiment. No.	List of Experiments
1.	Implement and perform operations on 1D, 2D, and 3D arrays, including initialization, insertion, deletion, and traversal.
2.	Design and implement the stack data structure using both array-based and linked list representations to demonstrate LIFO (Last-In, First-Out) operations.
3.	Develop programs to implement queue structures using arrays and linked lists, showcasing FIFO (First-In, First-Out) behavior, including variations like linear and circular queues.
4.	Construct and manipulate singly linked lists through functions that support creation, insertion, deletion, and traversal of nodes.
5.	Develop functions to operate on doubly linked lists, enabling bi-directional traversal and supporting insertion and deletion at various positions.
6.	Implement circular linked list operations, demonstrating creation, insertion, deletion, and traversal, where the last node connects to the first to form a loop.
7.	Implement search algorithms using both recursive and iterative approaches, focusing on linear and binary search techniques over a list of integers.
8.	Develop sorting programs using elementary techniques, including bubble sort, selection sort, and quick sort, to arrange data in ascending or descending order.
9.	Implement efficient sorting algorithms, such as insertion sort, merge sort, and heap sort, to handle large and complex datasets with improved performance.
10.	Create and manipulate a Binary Search Tree (BST) by performing insertion, deletion, and search operations, maintaining an ordered binary structure.
11.	Demonstrate tree traversal algorithms, including In-order, Preorder, and Post-order methods, to systematically access and process each node of a binary tree.

Semester IV

Course Title:	**MICRO FABRICATION TECHNOLOGY**
Course Code:	**ECVB 405**
L-T-P:	**3–0–2**
Credits:	**4**
Pre-requisites:	**Engineering Physics (PHVB 204), Electronic Devices and Circuits (ECVB 302)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the CMOS process flow.	Understand (Level-II)
CO-2	Identify various critical processing steps in microfabrication.	Apply (Level-III)
CO-3	Apply the advanced methods involved in IC fabrication.	Apply (Level-III)
CO-4	Analyze the advancements in CMOS process fabrication with scaling in technology.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓				✓			✓	✓	✓				
CO-2	✓	✓	✓		✓			✓	✓	✓				
CO-3	✓				✓		✓	✓	✓	✓		✓	✓	✓
CO-4	✓			✓								✓	✓	✓

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Oxidation: Dry and Wet Oxidation, Kinetics of Oxidation, Oxidation Rate 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.	**9**
Module-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	**9**

	Straggle, Dose, Junction Depth, Ion Implantation Damage, Post Implantation Annealing, Ion Channelling, Multi Energy Implantation.	
Module-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**

Learning Resources:

Text Books:	1- "Silicon VLSI Technology" by Plummer, Deal, and Griffin, 1st Edition, Pearson Education, 2009. 2- "Fundamentals of Semiconductor Fabrication" by S.M. Sze and M.K. May, 2nd Edition, Wiley India, 2009.
Reference Books:	1- "Silicon Process Technology" by S.K. Gandhi, 2nd Edition, Wiley India, 2009.
Other Suggested Readings:	NPTEL Lectures.

List of Experiments:	
1.	Learn the techniques of Micro fabrication (Process simulator)
2.	Etching process
3.	Printing process
4.	Metallization

Course Title:	**DIGITAL SYSTEM DESIGN**
Course Code:	**ECVB 406**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Design, analysis and optimization of synchronous circuits.	Analyze (Level-IV)
CO-2	Design, analysis and optimization of asynchronous circuits	Analyze (Level-IV)
CO-3	To get exposure to FPGA architecture and Verilog HDL	Analyze (Level-IV)
CO-4	Use HDL and appropriate EDA tools for digital logic design and simulation	Apply (Level-III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	3	3	3								2	3	2
CO-2	2	3	3	3								2	3	2
CO-3	2	3	3	3	3							2	3	2
CO-4	2	3	3	3	3							2	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-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	**9**

	processors, Case study: FIFO, Traffic signal controller, newspaper vending machine.	
Module-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**

Learning Resources:

Text Books:	M. Morris Mano and Michel. D. Ciletti, Digital Design with an introduction to HDL, VHDL and Verilog Charles H. Roth Jr, Fundamentals of Logic Design
Reference Books:	Sunggu Lee, Advanced Digital Logic Design: Using VHDL, State Machine, and Synthesis for FPGAs
Other Suggested Readings:	

Course Title:	**ANALOG COMMUNICATION**
Course Code:	**ECVB 407**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals and Systems (ECVB 303)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Gain the knowledge of components of analog communication system.	Understand (Level-II)
CO-2	To analyze various methods of baseband/band pass Analog transmission and detection.	Analyze (Level-IV)
CO-3	Analyze and allocate performance objectives to components of an analog communicationsystem and to design analog communication systems.	Understand (Level-II)
CO-4	To evaluate the performance of analogue communications in the presence of noise.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**								**2**	**2**			**1**	**2**
CO-2	**3**	**3**							**2**	**2**			**3**	**3**
CO-3	**3**	**3**							**2**	**2**			**3**	**3**
CO-4	**3**	**2**							**2**	**2**			**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 in temperature limited diode and space charge limited diodes, Pulse response and Digital noise	**9**
Module-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**

Module-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**
Module-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**

Learning Resources: This course provides the graduate-level introduction to understand, analyze, characterize and design the operation of Transmitters, receivers to transmit and receive analog signal successfully using analog modulation techniques such as AM, FM & PM along with the Pulse Modulation and impact of noise on signal.

Learning Resources:

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
3	Title	Modern Digital and Analog Communication Systems
	Author	B.P. Lathi
	Publisher	Oxford University Press
	Edition	3/e, 1998
	Reference Books:	
1	Title	Introduction to Communication Systems
	Author	B. Carlson
	Publisher	McGraw-Hill
	Edition	4/e, 2009
2	Title	Modern Communication Circuits
	Author	J. Smith
	Publisher	McGraw Hill
	Edition	2/e, 1997
3	Title	Modern Electronic Communication
	Author	J. S. Beasley & G. M. Miler
	Publisher	Prentice Hall
	Edition	9/e, 2008
	Other Suggested Readings:	

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 Superheterodyne Receiver.
6.	Selectivity of a Superheterodyne Receiver.
7.	Fidelity of a Superheterodyne Receiver.
8.	Study of Pulse Amplitude Modulation/Demodulation.
9.	Study of Pulse Width Modulation/Demodulation.
10.	Study of Pulse Position Modulation/Demodulation

Course Title:	**MICROPROCESOR AND MICROCONTROLLER**
Course Code:	**ECVL 408**
L-T-P:	**3–0–2**
Credits:	**4**
Pre-requisites:	**Basics of Electrical and Electronics Engineering (EEVB 103)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Demonstrate the architecture of 8085, 8086, 8051and ARM and their addressing modes and instruction set.	Understand (Level-II)
CO-2	Understand the need and use of Peripherals and Interfacing and develop skill to explore system design technique.	Understand (Level-II)
CO-3	To understand the RISC and CISC architecture and to explore the ARM architecture.	Understand (Level-II)
CO-4	Analyze microprocessor and microcontroller-based system design and impart knowledge on embedded S/W development.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓		✓	✓			✓			✓	✓		✓	
CO-2			✓	✓			✓			✓		✓	✓	✓
CO-3			✓	✓		✓	✓		✓	✓			✓	
CO-4			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-III	8051 – Architecture, Special Function Registers (SFRs), Instruction set, Addressing modes, Assembly language programming, I/O Ports, Timers / counters, Interrupts and serial communication.	**9**
Module-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.	**9**

	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. .	

Learning Resources:

Text Books:	1)Microprocessor Architecture, Programming and Applications with 8085, Ramesh S. Gaonkar, Penram International Publishing reprint, 6th Edition, 2017 2)Microprocessor and Interfacing, Programming and Hardware Douglas V. Hall, Tata McGraw Hill Revised 2nd Edition 2006, 11th reprint 2015
Other Suggested Readings:	The 8051 Microcontroller and Embedded Systems Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D. McKinley Pearson Education 2nd Edition,12th impression 2018

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 microcontroller. 9. Programming and verifying Timer, Interrupts and UART operations in 8051 microcontroller. 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 Title:	**DIGITAL SIGNAL PROCESSING**
Course Code:	**ECVB 409**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signals & Systems (ECVB 303)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Define discrete-time signals analytically and visualize them in the time domain.	Remember (Level-I)
CO-2	Understand the meaning and implications of the properties of systems and signals.	Understand (Level-II)
CO-3	Understand the Transform domain and its significance and problems related to computational complexity.	Understand (Level-II)
CO-4	Assess to specify and design any digital filters using MATLAB	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO-2	**3**	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO-3	**3**	**3**	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO-4	**3**	**3**	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-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.	**10**
Module-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.	**10**
Module-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.	**12**
Module-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.	**16**

	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	

Learning Resources:

Text Books:	1	Digital Signal Processing: A Computer-Based Approach
		S. K. Mitra
		McGraw-Hill
		Third edition, 2006
	2	Discrete-Time Signal Processing
		A. Oppenheim and R. Schafer
		Prentice Hall
		Second edition, 1999
Reference Books:	1	Schaum's Outline of Digital Signal Processing
		M. Hays
		McGraw-Hill
		1999
Other Suggested Readings:		NPTEL Lectures, Research papers

List of Experiments:

1. Study of Floating-Point Digital Signal Processor & Fixed-Point Digital Signal Processor.
2. Realisation of Circular & Linear Convolution and Correlation of two sequences.
3. Computation of DFT & IDFT of a given Sequence using DSP Processors.
4. Classification, denoising of real time signals.
5. Radix-2 & Radix-4 algorithm FFT Calculation using DSP Processors.
6. FIR & IIR Filter Implementation using the DSP Processors.
7. Basics of MATLAB-Realisation of Unit Impulse, Unit Step & Unit Ramp signals.
8. Linear & Circular Convolution of two Sequences, Correlation of two sequences.
9. DFT & IDFT Computation.
10. Radix-2 algorithms FFT Calculation.
11. Generation of Gaussian Distributed Numbers.

Course Title:	**MINI PROJECT**
Course Code:	**ECVP 410**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	

Course Outcomes:

CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	2	3	3	3				2		3	3	2	3
CO-3	3	3	3	2	3	1			3		2	2	3	2
CO-4	1	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Description: Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Evaluation Criteria:
The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Identification of Problem Domain.	**10**
II	Study of Existing Systems and establishing clear objectives.	**20**
III	Planning of project and work distribution within the team.	**30**
IV	Proper Documentation and Technical Writing.	**25**
V	Presentation and Response to questions.	**15**

Evaluation Criteria-CO Mapping

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.

It is desirable that students should work on the project in group of 2 or 3 but not more than three.

After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.

At the end, students must submit the final report of the project and the format for the same will be given by the department.

The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.

The students will report to the respective guide/supervisor at every fortnight to discuss their progress.

The final evaluation of the project will be done based on the demonstration and presentation.

Semester V

Course Title:	**Digital Communication**
Course Code:	**ECVB 511**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Signal and Systems (ECVB 303); Analog Communication (ECVB 407)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To describe the basic building blocks of a digital communication system and understand the concept of sampling and bandwidth. Revision of Fourier series and transform concepts.	Understand (Level-II)
CO-2	To compare and contrast various line coding techniques for efficient digital data transmission and to analyze all waveform coding schemes for digital communication systems.	Apply (Level-III)
CO-3	To design the digital radio receiver structure and analyze the performance of receivers in terms of probability of error in presence of noise.	Analyze (Level-IV)
CO-4	To explain and discuss all binary and multilevel digital modulation techniques and evaluate the performance of these techniques in terms of bit error rate and spectral efficiency.	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	-	-	-	3	-	-	-	2	2	-	-	1	2
CO-2	3	3	-	-	3	-	-	-	2	2	-	-	3	3
CO-3	3	3	3	-	3	-	-	-	2	2	-	-	3	3
CO-4	3	2	-	-	3	-	-	-	2	2	-	-	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Introduction:** Introduction to Digital Communication System, Basic block diagram of system, need of digital communication, Guided and unguided transmission media, concept of bandwidth, Electromagnetic spectrum and its usage, Review of Signal representation using Fourier Series &Transform, Review of Sampling Theorem. **Probability and Random Processes:** Basic introduction, Properties of probability, Random variables, CDF & PDF of random variables, Joint CDF & PDF, Marginal Densities, Statistical averages, Random processes, types of random processes.	**09**
Module-II	**Line Coding:** Basic introduction, Need and properties of line coding techniques, NRZ, RZ, Manchester encoding, Differential Manchester Encoding, AMI coding, High density bipolar code, Binary with n-zero substitution codes **Waveform Coding:** Uniform and Non-uniform Quantization, Commanding, μ- Law and A-Law compressors, Concept & Analysis of	**09**

	PCM, DPSM, DM & ADM Modulators and demodulators, SNR for all techniques, Probability of error for PCM & other modulation techniques.	
Module-III	**Digital Modulation Schemes:** Coherent Binary Schemes: ASK, FSK, PSK, QPSK, MSK. Coherent M-ary Schemes, Incoherent schemes DPSK, Calculation of Average Probability of Error for different Modulation Schemes, Power Spectra of Digitally modulated signals, Performance comparison of different digital modulation schemes.	**09**
Module-IV	**Designing of Receivers:** Analysis of Digital receivers, Error performance degradation in radio receivers, Demodulation and Detection, Maximum Likelihood Receiver structure, Design and Properties of Matched Filter, Coherent receiver Design, Inter Symbol Interference, Eye Pattern	**09**

Learning Resources: This course provides the graduate-level introduction to understand, analyze, characterize and design the transmission and reception of digital signals along with modulation processes such as ASK, FSK, PSK & more; including the design and analysis of Matched filter.

Text Books:		
1	Title	Digital Communication
	Author	John G. Proakis
	Publisher	Tata McGraw
	Edition	4^{th}
2	Title	Communication Systems
	Author	Simon Haykins
	Publisher	John Wiley & Sons
	Reference Books:	
1	Title	Modern Digital & Analog Communication
	Author	B.P.Lathi
	Publisher	Oxford University Press
	Edition	3^{rd}
2	Title	Principles of Communication Systems
	Author	Taub Schilling
	Publisher	Tata McGraw Hill
	Edition	2^{nd}
	Other Suggested Readings:	

List of Experiments:	
1.	Write a program to generate a periodic as well as a periodic signal.
2.	Write a program to generate following line-coding techniques. a. NRZ signal b. RZ signal c. Alternate Mark Inversion d. Polar Quaternary e. Manchester coding techniques f. Write a code to generate the signal 1101001100 for all coding techniques.
3.	Write a program to generate a sample signal along with its reconstruction that is from analog to sample and then reverse.

4.	Write a program to study and calculate SNR of PCM using MATLAB
5.	Write a program to study DPCM modulation and demodulation techniques using MATLAB.
6.	Write a program to study Delta Modulation Technique using MATLAB
7.	Write a program to study Adaptive Delta Modulation techniques using MATLAB
8.	Write a program to study Amplitude Shift Keying (ASK) technique using MATLAB.
9.	Write a program to study Frequency Shift Keying (FSK) technique using MATLAB
10.	Write a program to study Phase Shift Keying (PSK) technique using MATLAB
11.	Write a program to study Differential Phase Shift Keying (DPSK) technique using MATLAB
12.	Write a program to study Quadrature Phase Shift Keying (QPSK) technique using MATLAB
13.	Write a program to study Quadrature Amplitude Modulation (QAM) technique using MATLAB
14.	Write a program to generate a periodic as well as a periodic signal.

Course Title:	**DIGITAL VLSI DESIGN**
Course Code:	**ECVB 512**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Digital Electronics (ECVB 304)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Interpret the design of digital integrated circuits, MOS fundamentals and analysis of MOSFET-based digital circuits.	Understand (Level-II)
CO-2	Design and study the MOS inverters and combinational circuits,	Apply (Level-III)
CO-3	Design the CMOS-based sequential circuit, dynamic logic circuits and MOS memories.	Create (Level-VI)
CO-4	To understand the VLSI design flow and design styles.	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-3	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	2	1	1	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	The MOS Inverter: Inverter principle, the basic CMOS inverter, transfer 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.	**9**
Module-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.	**9**

	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.	
Module-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**

Learning Resources:

Text Books:	Title CMOS Digital Integrated Circuits Author Sung-Mo Kang, Yusuf Leblebici Publisher Tata McGraw Hill Edition 2014 Title Digital Integrated Circuits: A Design Perspective Author J.M Rabaey, A. Chandrakasan, B.Nikolic Publisher Pearson Edition 2012
Reference Books:	Title : Introduction to VLSI Circuits and Systems Author J. P. Uyemura Publisher Wiley Edition 2006
Other Suggested Readings:	CMOS VLSI Design: A Circuits and Systems Perspective Neil H.E. Weste, David Harris Pearson Education 2015

List of Experiments:	**Suggested list**
1.	To study the NMOS and PMOS Drain and Gate characteristics.
2.	To design and study the DC characteristics of resistive inveter.
3.	To design and study the transient and DC characteristics of CMOS inverter.
4.	To design and study the output characteristic of BiCMOS inverter.
5.	To design and study the characteristics of CMOS NAND gate
6.	To design and study the characteristics of CMOS NOR gate.
7.	To design and study the transient characteristics of CMOS XOR gate.
8.	To design and study the transient characteristics of CMOS XNOR gate.
9.	To design and study the characteristics of CMOS based multiplexer.
10.	To design any Given Boolean function using transmission gates and CMOS logic.
11.	To design and study the characteristics of CMOS based D Flip Flop.
12.	To design and study the characteristics of Schmitt trigger circuit.

Course Title:	**SEMICONDUCTOR PACKAGING AND TESTING**
Course Code:	**ECVB 513**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Semiconductor Materials (ECVL 201)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the basics of semiconductor packaging and the process from sand to silicon.	Understand (Level-II)
CO-2	Learn about different packaging methods like wire bonding, TAB, and flip-chip.	Apply (Level-III)
CO-3	Identify packaging materials and understand current trends like MCM and SIP.	Create (Level-VI)
CO-4	Explore packaging advancements and roadmaps for future technologies.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	1	1	1	1	1	1	1	1	2	3	2
CO-2	3	3	2	2	2	1	1	1	1	2	2	2	3	3
CO-3	3	2	3	2	2	2	2	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	2	2	2	3	3	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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), 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.	**9**
Module-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;	**9**

	Technology file generation from CAD; DFM checklist and design rules; Design for Reliability.	
Module-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**
Module-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**

Learning Resources:

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

Course Title:	**ALGORITHM FOR VLSI DESIGN**
Course Code:	**ECVB 514**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Data Structure and Programming (CSVB 306), Digital System Design (ECVB 406)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Learn the basics of logic synthesis, binary decision diagrams, and hardware models for high-level synthesis.	Understand (Level-II)
CO-2	Understand and apply partitioning algorithms like group migration, simulated annealing, and other methods	Analyze (Level-IV)
CO-3	Solve problems related to placement, floor planning, and pin assignment using various algorithms	Apply (Level-III)
CO-4	Explore and use routing techniques, including maze routing, Steiner tree methods, and multi-layer routing.	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	2	3	3	1	1	1	1	2	2	2	3	3
CO-3	3	2	3	2	3	2	1	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	2	1	1	3	3	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Logic synthesis & verification: Introduction to combinational logic synthesis, Binary decision diagram, Hardware models for High-level synthesis.	**09**
Module-II	VLSI automation Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms.	**09**
Module-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.	**09**
Module-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.	**09**

Learning Resources:

Text Books:	Title Algorithms for VLSI physical design Automation Author Naveed Shervani Publisher Kluwer Academic Publisher Edition 3rd edition, 1999 Title Algorithm and Data Structures for VLSI Design Author Christophn Meinel & Thorsten Theobold Publisher Kluwer Academic Publisher Edition 2002
Reference Books:	Title Evolutionary Algorithm for VLSI CAD Author Rolf Drechsheler Publisher Kluwer Academic Publisher Edition 2nd edition 2010
Other Suggested Readings:	

Course Title:	**SEMINAR/ SUMMER INTERNSHIP-I**
Course Code:	**ECVP 516**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	2	3	2	3	2				2		2	3	2	3
CO-3	3	1	3	2	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Description: Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Evaluation Criteria: The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	**Description**	**Weightages**
I	Identification of Problem Domain.	**10**
II	Study of Existing Systems and establishing clear objectives.	**20**
III	Planning of project and work distribution within the team.	**30**
IV	Proper Documentation and Technical Writing.	**25**
V	Presentation and Response to questions.	**15**

CO / Criteria	**CO-1**	**CO-2**	**CO-3**	**CO-4**

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three. After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

Semester VI

Course Title:	**EMBEDDED AND REAL-TIME OPERATING SYSTEMS**
Course Code:	**ECVB 617**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Microprocessors and Microcontrollers (ECVB 408), Algorithm for VLSI Design (ECVB 514)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Explain the basics of an embedded system and its approaches.	Understand (Level-II)
CO-2	Identify the various methods of Hardware Implementation.	Apply (Level-III)
CO-3	Analyze the clocking issues in embedded systems.	Analyze (Level-IV)
CO-4	Compile the operating systems concepts, types and RTOS.	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1				1					1	3	2
CO-2	1	2	3	1	1		1					2	3	2
CO-3	1	2	3	2	1		1					2	3	2
CO-4	1	1	2	3	1		1					3	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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.	**09**
Module-II	Typical Embedded System: Core of the Embedded System: General Purpose 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	**09**
Module-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.	**09**
Module-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.	**09**

Learning Resources:

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
		2013
	3:Title	Real-time concepts for embedded systems
	Author	Li, Qing, and Caroline Yao
	Publisher	CRC press
	Edition	2003
Reference Books:	1:Title	An Embedded Software Primer
	Author	David E. Simon
	Publisher	Pearson
	Edition	2013
Other Suggested Readings:	1: Wang KC. Embedded real-time operating systems. InEmbedded and Real-Time Operating Systems 2023 Sep 15 (pp. 429-503). Cham: Springer International Publishing. 2: Li Y, Potkonjak M, Wolf W. Real-time operating systems for embedded computing. InProceedings International Conference on Computer Design VLSI in Computers and Processors 1997 Oct 12 (pp. 388-392). IEEE.	

List of Experiments:	**Laboratory Sessions**
1.	Create an application that creates two tasks that wait on a timer whilst the main task loops.
2.	Write an application that creates a task which is scheduled when a button is pressed, which illustrates the use of an event set between an ISR and a task
3.	Write an application that Demonstrates the interruptible ISRs (Requires timer to have higher priority than external interrupt button)
4.	a). Write an application to Test message queues and memory blocks. b). Write an application to Test byte queues
5.	Write an application that creates two tasks of the same priority and sets the time slice period to illustrate time slicing.
6.	Interfacing Programs: Write an application that creates a two task to Blinking two different LEDs at different timings
7.	Write an application that creates a two task to Blinking two different LEDs at different timings
8.	Write an application that creates a two-task displaying two different messages in LCD display in two lines.
9.	Sending messages to mailbox by one task and reading the message from mailbox by another task.
10.	Sending message to PC through serial port by three different tasks on priority Basis.

Course Title:	**ANALOG VLSI DESIGN**
Course Code:	**ECVB 618**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Basics of Electrical and Electronics Engineering (EEVB 103), Electronic Devices and Circuits (ECVB 302), Digital VLSI Design (ECVB 512)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understanding the MOS Operation and small signal models.	Understand (Level-II)
CO-2	Analyze single-stage amplifiers with different loads.	Analyze (Level-IV)
CO-3	To design single and differential CMOS amplifiers	Create (Level-VI)
CO-4	Understanding the role of feedback in amplifiers.	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓	✓	✓	✓										
CO-2	✓	✓	✓	✓										
CO-3	✓	✓	✓	✓										
CO-4	✓	✓	✓	✓										

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-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,	**9**

	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.	
Module-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**

Learning Resources:

Text Books:	1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, McGraw Hill Education, 2000 2. CMOS Analog Circuit Design, Phillip Allen and Douglas R. Holberg, OUP USA, 3rd Edition, 2011
Reference Books:	1.Operation and Modelling of the MOS Transistor, Yannis Tsividis, Oxford University Press, 2ndedition, 2003
Other Suggested Readings:	"Microelectronic Circuits" – Sedra & Smith "Analog Integrated Circuit Design" – Tony Chan Carusone, David Johns, and Kenneth Martin

Course Title:	**MINOR PROJECT**
Course Code:	**ECVP 619**
L-T-P:	**0-0-4**
Credits:	**2**
Pre-requisites:	**NA**

Course Outcomes:

CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	3	3	3	2				2		2	3	2	3
CO-3	3	3	2	3	3	1			3		2	2	3	2
CO-4	3	2	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Description:
Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project.

Evaluation Criteria: The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Identification of Problem Domain.	**10**
II	Study of Existing Systems and establishing clear objectives.	**20**
III	Planning of project and work distribution within the team.	**30**
IV	Proper Documentation and Technical Writing.	**25**
V	Presentation and Response to questions.	**15**

Evaluation Criteria-CO Mapping

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.

It is desirable that students should work on the project in group of 2 or 3 but not more than three.

After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.

At the end, students must submit the final report of the project and the format for the same will be given by the department.

The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.

The students will report to the respective guide/supervisor at every fortnight to discuss their progress.

The final evaluation of the project will be done based on the demonstration and presentation.

Course Title:	**PROJECT-BASED LEARNING**
Course Code:	**ECVP 620**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

CO-1	Select appropriate Hardware for project work.
CO-2	Identify the appropriate software tools for design & Simulation.
CO-3	Apply appropriate Hardware & Software tools to execute the project work.
CO-4	Write a technical project report & develop presentation, communication skills through the project work. Develop an ability to work in a team.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	3	2	3	1	2	1	2		2	1	3	1
CO-2	1	2	3	1	3	1	1		3	1	3	1	2	1
CO-3	2	2	3	1	3	1	1		3	1	1	1	3	1
CO-4	1	1	1	2	1	1	2		3	2	3	1	2	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Description: Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Evaluation Criteria: The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	**Description**	**Weightages**
I	Identification of Problem Domain	**10**
II	Study of Existing Systems and establishing clear objectives	**20**
III	Planning of project and work distribution within the team	**30**
IV	Proper Documentation and Technical Writing	**25**
V	Presentation and Response to questions	**15**

Evaluation Criteria-CO Mapping

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three.
After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

Semester VII

Course Title:	**LOW POWER VLSI DESIGN**
Course Code:	**ECVL 721**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Digital VLSI Design (ECVB 512), Analog VLSI Design (ECVB 618)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand the importance of low power design.	Understand (Level-II)
CO-2	To study the various source of power consumption in CMOS circuits.	Understand (Level-II)
CO-3	To apply the techniques to reduce the power dissipation in CMOS circuits.	Apply (Level-III)
CO-4	To analyse the circuit with probabilistic power technique.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	1								2	1	1
CO-2	2	2	1	1								1	2	1
CO-3	3	3	3	3								2	3	2
CO-4	2	3	1	2								2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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
Module-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
Module-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
Module-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

Learning Resources:

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 Title:	**VLSI VERIFICATION AND TESTING**
Course Code:	**ECVL 722**
L-T-P:	**3-0-2**
Credits:	**4**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Digital VLSI Design (ECVB 512), Analog VLSI Design (ECVB 618)**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	Understand the requirement of fault modelling in VLSI circuits.	Understand (Level-II)
CO-2	Analyze test vectors to test a circuit efficiently covering maximum faults.	Analyze (Level-IV)
CO-3	Apply the concept of Memory testing techniques.	Apply (Level-III)
CO-4	Evaluate Built-in-Self Test and its application in modern digital design.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**2**	**1**	**1**							**2**	**2**	**1**
CO-2	**2**	**3**	**2**	**1**	**1**							**2**	**2**	**1**
CO-3	**2**	**3**	**2**	**1**	**1**							**2**	**2**	**1**
CO-4	**2**	**3**	**2**	**1**	**1**							**2**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Physical faults and their modelling. Fault equivalence and dominance; fault collapsing, Fault simulation: parallel, deductive and concurrent techniques; critical path tracing.	**9**
Module-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**
Module-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**
Module-IV	Built-in self-test techniques: LBIST and MBIST. Verification: logic level (combinational and sequential circuits), RTL-level (data path	**9**

	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.	

Learning Resources:

Text Books:	1. "Essentials of Electronic Testing" by M. L. Bushnell and V. D. Agrawal, Kluwer Academic Publishers, 3rd edition 2002. 2. "Delay Fault Testing for VLSI Circuits" by A. Krstic and K-T Cheng, Kluwer Academic Publishers, 3rd edition 2003
Reference Books:	"Testing of Digital Systems" by N. K. Jha and S. Gupta, Cambridge University Press, 2nd edition 2003
Other Suggested Readings:	

Course Title:	**ENGINEERING ECONOMICS AND ACCOUNTANCY**
Course Code:	**HMVL 703**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Develop and understand the basic concepts of economics and business firms' working at the organizational level.	Understand (Level-II)
CO-2	Analyse the capital budgeting with possible engagement between investment decision-making and economic efficiency.	Apply (Level-II)
CO-3	Understand the foundational concepts of financial accounting and the role of entrepreneurship at the firm level for engineers.	Analyze (Level-IV)
CO-4	Evaluate and understand the broad economic role of the government sector, investors, and market structure in the working of the overall economy and more specifically internal markets.	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**1**	**-**	**-**	**2**	**-**	**2**	**1**	**-**	**-**	**-**	**3**	**1**	1	-
CO-2	**3**	**1**	**-**	**2**	**-**	**2**	**1**	**1**	**-**	**-**	**3**	**2**	1	2
CO-3	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**1**	-	3
CO-4	**1**	**1**	**-**	**1**	**-**	**1**	**1**	**1**	**-**	**-**	**3**	**3**	1	1
Average	**1.25**	**0.5**	**0**	**1.25**	**0**	**1.75**	**0.75**	**0.5**	**0**	**0**	**3**	**1.75**	**0.75**	**1.5**

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Engineering Economics:** Introduction to Engineering Economics, Time value of money –compounding and discounting. Cash flow and Time Diagrams, Choosing between alternative investment proposals.	**8**
Module-II	**Capital Budgeting:** Methods of Economic Analysis (Pay back, ARR, NPV, IRR, and B/C ratio). Depreciation and methods of calculating depreciation (Straight line, Sum of the years digit method, Declining Balance Method, Annuity Method, Sinking Fund method. Breakeven point Analysis – Meaning and its application, Limitation.	**8**
Module-III	**Macroeconomics and its Economic Issues:** National Income Accounting – Methods of Estimation – Various Concepts of National Income – Significance of National Income Estimation and its limitations. Inflation: Definition- Measures to Control (Monetary and Fiscal policy), Stagflation	**8**

Module-IV	**Financial Accounting:** Accounting Principles, procedure entry system – Journal, ledger, Trial balance – Cash Book – Preparation of Trading and Profit and Loss account – Balance Sheet. Strategic Entrepreneurship and Entrepreneur, Techno Entrepreneurship.	**8**
Module-V	**Managerial Economics:** Scope of Managerial Economics: Theory of Demand and Theory of Supply. Law of demand and Law of Supply. Techniques of Managerial Economics; Theory of firm, Theory of Market Structure. Applications of Managerial Economics.	**4**

Learning Resources:

Text Books:

Reference Books:

1. Engineering Economics by R. Paneerselvam, PHI Learning, Second Edition.
2. Fundamentals of Engineering Economics by Pravin Kumar,Wiley Publications, First Edition.
3. Advanced Economic Theory: Microeconomic Analysis by H.L. Ahuja S.Chand 20th Revised Edition

Other Suggested Readings:

1. Principles of Engineering Economics with Applications by Zahid A.Khan, Arshad, Brajesh Kumar, Mustafa H. Abidi, Cambridge Press, Second Edition.

Course Title:	**SEMINAR/ SUMMER INTERNSHIP-II**
Course Code:	**ECVP 723**
L-T-P:	**0-0-2**
Credits:	**1**
Pre-requisites:	**NA**

Course Outcomes:

CO-1	Understand, plan, and execute the project with team.
CO-2	Students will be able to practice acquired knowledge within the chosen area of technology for project development.
CO-3	Identify, discuss, and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
CO-4	Communicate and report effectively project related activities and findings.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	2	3	1	3	3				2		1	3	2	3
CO-3	3	2	3	2	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Description: Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Evaluation Criteria: The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	**Description**	**Weightages**
I	Identification of Problem Domain.	**10**
II	Study of Existing Systems and establishing clear objectives.	**20**
III	Planning of project and work distribution within the team.	**30**
IV	Proper Documentation and Technical Writing.	**25**
V	Presentation and Response to questions.	**15**

CO / Criteria	**CO-1**	**CO-2**	**CO-3**	**CO-4**

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three.
After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

Semester VIII

Course Title:	**MAJOR PROJECT/INTERNSHIP**
Course Code:	**ECVP 824**
L-T-P:	**0-0-0**
Credits:	**16**
Pre-requisites:	**NA**

Course Outcomes:

CO-1	Select appropriate Hardware for project work.
CO-2	Identify the appropriate software tools for design & Simulation.
CO-3	Apply appropriate Hardware & Software tools to execute the project work.
CO-4	Write a technical project report & develop presentation, communication skills through the project work. Develop an ability to work in a team.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	3	2	3	1	2	1	2		2	1	3	1
CO-2	1	2	3	1	3	1	1		3	1	3	1	3	1
CO-3	1	2	3	1	3	1	1		3	1	3	1	3	1
CO-4	1	1	1	2	1	1	2		3	2	3	1	2	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Description: Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Evaluation Criteria: The B.Tech. Project work will be evaluated for 100 marks, with the following weightages:

Component	**Weightages**
Periodic evaluation by Guide	**40 Marks**
Mid-term review	**20 Marks**
End Semester viva-voce examination	**40 Marks**
Total	**100 marks**

The midterm review and the end semester viva-voce examination will be conducted by a committee constituted by the Head of the Department. If the performance of a student is not satisfactory, he/ she can be awarded 'F' grade. Such a student will be given a maximum time of three months to improve his/her performance. If the performance of such a student is not satisfactory even after the extended time period, he/ she will have to repeat the project work in the next academic year**.**

Course Title:	**INDEPENDENT STUDY & SEMINAR**
Course Code:	**ECVP 825**
L-T-P:	**0-0-8**
Credits:	**4**
Pre-requisites:	**NA**

Course Outcomes:

CO-1	Select appropriate Hardware for project work.
CO-2	Identify the appropriate software tools for design & Simulation.
CO-3	Apply appropriate Hardware & Software tools to execute the project work.
CO-4	Write a technical project report & develop presentation, communication skills through the project work. Develop an ability to work in a team.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	-	-	2	2	2	3	2	2
CO-2	3	3	3	3	3				2		2	3	2	3
CO-3	3	3	3	3	3	1			3		2	2	3	2
CO-4	3	3	3	3	3	2					2	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Description: Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project.

Evaluation Criteria: The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Identification of Problem Domain	**10**
II	Study of Existing Systems and establishing clear objectives	**20**
III	Planning of project and work distribution within the team	**30**
IV	Proper Documentation and Technical Writing	**25**
V	Presentation and Response to questions	**15**

Evaluation Criteria-CO Mapping

CO / Criteria	CO-1	CO-2	CO-3	CO-4

Course Guidelines:

Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
It is desirable that students should work on the project in group of 2 or 3 but not more than three.
After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
At the end, students must submit the final report of the project and the format for the same will be given by the department.
The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
The final evaluation of the project will be done based on the demonstration and presentation.

Elective Courses

Bouquet 1: Elective I

Course Title:	**SEMICONDUCTOR DEVICE MODELLING**
Course Code:	**PEVL 501**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Basics of Semiconductor Materials (ECVL 201)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	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)
CO-2	Apply suitable approximations and techniques to derive the model starting from drift-diffusion transport equations.	Apply (Level-III)
CO-3	Examine clues to a qualitative understanding of the physics of a new device and conversion of this understanding into equations.	Evaluate (Level-V)
CO-4	Compile characteristics of a simple device using MATLAB, and SPICE tools.	Create (Level-VI)

Course Articulation Matrix:

Course Articulation Matrix:														
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	2	2	1	1	1	1	2	1	2	3	3
CO-3	3	3	3	3	2	1	1	1	1	2	1	2	3	3
CO-4	3	3	3	3	3	2	2	1	2	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 Contacts, forward and reverse-biased junctions, reverse bias breakdown, transient, and a-c conditions.	**9**
Module-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**

Module-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**
Module-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%	

Learning Resources:	
Text Books:	Title Solid State Electronic Devices Author B. G. Streetman and S. Banerjee Publisher PHI Private Limited Edition 2011 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:	Title Introduction to Semiconductor Materials and devices Author M.S Tyagi Publisher John Wiley & Sons Edition 2005
Other Suggested Readings:	

Course Title:	**DIGITAL IMAGE PROCESSING**
Course Code:	**PEVL 502**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital Signal Processing (ECVB 409)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Analyze images in the frequency domain using various transforms.	Analyze (Level-IV)
CO-2	Evaluate the techniques for image enhancement and image restoration.	Evaluate (Level-V)
CO-3	Categorize various compression techniques.	Analyze (Level-IV)
CO-4	Interpret Image compression standards, segmentation and representation techniques.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	3	2	1	1	1	1	2	2	2	3	3
CO-3	3	3	2	2	2	1	1	1	1	2	1	2	3	2
CO-4	3	3	3	3	3	2	2	1	1	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-III	Wavelet transform for Image Processing: Multi resolution expansion, Wavelet functions, Wavelet Series expansion, Continuous and Discrete Wavelet transforms, Wavelet	**9**

	transforms for two dimensional signals (images), Applications of wavelet transforms for edge extraction, noise suppression.	
Module-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%	

Learning Resources:	
Text Books:	Title Digital Image Processing Author R. C. Gonzalez and R. E. Woods Publisher Pearson Education Edition Third edition, 2009 Title Fundamental of Digital Image Processing Author Anil K Jain Publisher Prentice Hall Edition 1989
Reference Books:	Title The essential guide to image processing Author A. C. Bovik Publisher Academic Press Edition Second edition 2009
Other Suggested Readings:	

Course Title:	**INTERNET OF THINGS**
Course Code:	**PEVL 503**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Signals and Systems (ECVB 303)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	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)
CO-2	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)
CO-3	Develop different communication standards and technologies to choose appropriate communication technology for designing of IoT system.	Apply (Level-III)
CO-4	Evaluate the Medium Access Protocols, routing algorithms and their implementations.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-3	3	3	3	2	3	1	1	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	2	1	1	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 and sensing modules---of off-the-shelf prototyping boards, e.g., Arduino UNO, MSP430 Launch Pad; Node MCU, STM32.	**9**
Module-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**
Module-III	Performance evaluation of IoT systems: Developing mathematical models for energy consumption, Optimal node placement, and	**9**

	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.	
Module-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**

Learning Resources:	
Text Books:	Title Internet of Things Author Dr. Jeeva Jose Publisher Khanna Book Publishing Company Edition 2018 Title Introduction to Security of Cyber-Physical Systems Author Dr. Jeeva Jose & Vijo Mathew Publisher Khanna Book Publishing Company Edition 2022
Reference Books:	Title The Internet of Things: Enabling Technologies, Platforms, and Use Cases Author Pethuru Raj and Anupama C. Raman Publisher CRC Press Edition 2017
Other Suggested Readings:	

Course Title:	**WIRELESS COMMUNICATION**
Course Code:	**PEVL 504**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECVB 407), Digital Communication (ECVB 511)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Discuss the cellular system design and technical challenges.	Understand (Level-II)
CO-2	Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.	Analyze (Level-IV)
CO-3	Analyze the design parameters, link design, smart antenna, beam forming and MIMO systems.	Analyze (Level-IV)
CO-4	Analyze Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts. summarize the principles and applications of wireless systems and standards	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-3	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	2	1	1	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Mobile radio propagation: Reflection, Diffraction. Fading. Multipath Propagation. Channel modeling, Diversity Schemes and Combining Techniques.	**9**
Module-III	Design parameters at the base station, Practical link budget design using path loss models. Smart antenna systems, Beamforming. MIMO Systems. RAKE receiver.	**9**
Module-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**

Learning Resources:	
Text Books:	Title Wireless Communications Author : A.F.Molisch Publisher Wiley Edition 2005 Title Wireless Communications Author A.Goldsmith Publisher Cambridge University Press Edition 2005
Reference Books:	Title Wireless Communications Author P.Muthu Chidambara Nathan Publisher PHI Edition 2008
Other Suggested Readings:	

Course Title:	**DIGITAL SIGNAL PROCESSOR AND ARCHITECTURE**
Course Code:	**PEVL 505**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital Signal Processing (ECVB 409)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand Architectures for programmable DSP devices	Understand (Level-II)
CO-2	Analyze the Execution, control and pipelining of DSP devices	Analyze (Level-IV)
CO-3	Examine Programmable digital signal processors	Apply (Level-III)
CO-4	Apply the basic DSP algorithms	Apply (Level-III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-3	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	1	1	1	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	EXECUTION CONTROL AND PIPELINING: Hardware looping, Interrupts, Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branching effects, Interrupt effects, and Pipeline Programming models.	**9**
Module-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**
Module-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	**9**

	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.	

Learning Resources:	
Text Books:	Title Digital Signal Processors, Architecture, Programming and Applications Author B. Venkataamani and M. Bhaskar Publisher TMH Edition 2004 Title Digital Signal Processing- A practical approach Author Ifeachor & Jervis Publisher Pearson Education Edition 2005
Reference Books:	TMS320C50, TMS320C54XX, TMS320C6713 databooks
Other Suggested Readings:	

Course Title:	**ANTENNA THEORY AND DESIGN**
Course Code:	**PEVL 506**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECVB 407), Digital Communication (ECVB 511)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the Antenna theory, Radiation Pattern and wave equations.	Understand (Level-II)
CO-2	Analyze the Antenna dipoles, loop pattern and Antenna array.	Analyze (Level-IV)
CO-3	Examine the types of Antenna and their configuration.	Evaluate (Level-V)
CO-4	Design the Antenna at microlevel and study their characteristics.	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	1	1	1	1	2	1	2	3	2
CO-2	3	3	3	3	2	1	1	1	1	2	1	2	3	3
CO-3	3	3	3	3	3	1	1	1	1	2	2	2	3	3
CO-4	3	3	3	3	3	2	2	1	1	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Infinitesimal dipole, Small Dipole, Finite length and Half-Wavelength Dipole – 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	**9**
Module-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	**9**

	Design, H-Plane Sectoral Horn – Analysis and Design Pyramidal Horn	
Module-IV	Basic of Microstrip Antenna, Designing of Rectangular Microstrip Antenna, Antenna Ranges, Gain Measurement, Radiation Pattern Measurement, Anechoic Chamber	**9**

Learning Resources:	
Text Books:	Title Antenna Theory Analysis and Design Author C. A. Balanis Publisher Wiley Publication Edition 3rd Edition Title Antennas: For All Applications Author Kraus, John D &, Ronald J Marhefka Publisher Tata McGraw Hill Edition 3rd Edition
Reference Books:	Title Antenna Theory and Design Author W. L. Stutzman and G. A. Thiele Publisher Wiley Publication Edition 2005
Other Suggested Readings:	

Bouquet 2: Elective-II and Elective III

Course Title:	**INTRODUCTION TO MEMS**
Course Code:	**PEVL 607**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Micro Fabrication Technology (ECVB 405), Semiconductor Packaging and Testing (ECVB 513)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand fundamental principles of sensing and actuation and corresponding scaling laws in MEMS.	Understand (Level-II)
CO-2	Construct a comprehensive perspective of various fabrication processes and materials used in microfabrication.	Apply (Level-III)
CO-3	Examine the principle, design, and fabrication techniques of leading exemplary devices in the MEMS industry.	Analyze (Level-IV)
CO-4	Design the basic MEMS devices using relevant mechanical/electrical/fluidic engineering principles.	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	3	1	2								2	3	2
CO-2	2	2	2	2								2	3	2
CO-3	2	2	1	2								2	3	2
CO-4	2	2	3	2								2	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Micromachining, Surface Micromachining, sacrificial layer processes, Stiction, Bulk Micromachining, Isotropic Etching, and Anisotropic Etching, Wafer Bonding, Mechanics of solids in MEMS/NEMS.	**9**
Module-III	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.	**9**
Module-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**

Learning Resources:	
Text Books:	Marc Madou, Fundamentals of Microfabrication and Nanotechnology Microsystem Design
Reference Books:	Chang Liu, Foundation of MEMS
Other Suggested Readings:	

Course Title:	**NANOELECTRONICS**
Course Code:	**PEVL 608**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Micro Fabrication Technology (ECVB 405)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the fundamentals of classical CMOS technology and the issues in scaling MOSFET in the sub-100nm regime.	Understand (Level-II)
CO-2	Analyze the non-classical transistors with new device structures and nanomaterials.	Analyze (Level-IV)
CO-3	Identify the issues in realizing Germanium and compound semiconductor MOSFET.	Apply (Level-III)
CO-4	Evaluate extensive materials characterization techniques that help in designing high-performance transistors.	Evaluate (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**2**	**3**	**1**	**2**								**2**	**3**	**2**
CO-2	**2**	**3**	**1**	**3**								**2**	**3**	**2**
CO-3	**2**	**3**	**1**	**3**								**2**	**3**	**2**
CO-4	**2**	**3**	**2**	**3**								**2**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	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.	**9**

Module-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**
Module-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**

Learning Resources:	
Text Books:	Y. Taur and T. Ning, Fundamentals of Modern VLSI Devices Plummer and Deal, Silicon VLSI Technology
Reference Books:	Brundle, C.Richard; Evans, Charles A. Jr.;Wilson, Shaun, Encyclopaedia of Materials Characterization
Other Suggested Readings:	

Course Title:	**CYBER SECURITY**
Course Code:	**PEVL 609**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Problem Solving and Computer Programming (CSVB 204)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the concept of Cyber security and issues and challenges associated with it.	Understand (Level-II)
CO-2	Analyze the cyber-crimes, their nature, legal remedies and as to how report the crimes through available platforms and procedures.	Analyze (Level-IV)
CO-3	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.	Apply (Level-III)
CO-4	Develop the basic concepts and algorithms related to E-Commerce and digital payments.	Evaluate (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	3	1	2								2	3	2
CO-2	2	3	1	2								2	3	2
CO-3	2	3	1	2								2	3	2
CO-4	2	3	3	2								2	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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 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.	**9**
Module-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,	**9**

	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.	
Module-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**

Learning Resources:	
Text Books:	Dr. Jeeva Jose & Vijo Mathew, Introduction to Security of Cyber-Physical Systems Debtoru Chatterjee, Cyber Crime and its Prevention in Easy Steps
Reference Books:	Debtoru Chatterjee, Cyber Attacks and Counter-Measures Made Simple
Other Suggested Readings:	

Course Title:	**ASIC AND FPGA DESIGN**
Course Code:	**PEVL 610**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Problem Solving and Computer Programming (CSVB 204)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the ASIC library and Design Flow.	Understand (Level-II)
CO-2	Analyze the RAM ROM technology and interconnects using Xilinx.	Analyze (Level-IV)
CO-3	Apply the logic synthesis ASIC schematic design and construction.	Analyze (Level-IV)
CO-4	Evaluate the FPGA floor planning and design using Xilinx family.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	3	1	2								2	3	2
CO-2	2	3	1	2								2	3	2
CO-3	2	3	2	2								2	3	2
CO-4	2	3	2	2								2	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Review of VHDL/Verilog, Anti fuse static RAM -EPROM and EEPROM technology, Xilinx I/O blocks. Programmable ASIC Interconnect	**9**
Module-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**
Module-IV	FPGA partitioning: Floor planning -placement -physical design flow -global routing –detailed routing -special routing circuit extraction -DRC. Design using Xilinx family FPGA.	**9**

Learning Resources:	
Text Books:	M. J. S. Smith,Application -Specific Integrated Circuits Kevin Skahill, Jay Legenhausen, VHDL for programmable logic
Reference Books:	John F. Wakerly, Digital Design: Principles and Practices
Other Suggested Readings:	

Course Title:	**RADAR ENGINEERING**
Course Code:	**PEVL 611**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Analog Communication (ECVB 407), Digital Communication (ECVB 511)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the principles of Radar jamming and Radar range.	Understand (Level-II)
CO-2	Analyze the target, their detection and interface	Analyze (Level-IV)
CO-3	Analyze the CW Radar, Doplar Radar and Tracking Radar	Analyze (Level-IV)
CO-4	Apply the pulse compression technique in Radar system Apply the pulse compression technique in Radar system	Apply (Level-III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	3	1	2			1					2	3	2
CO-2	2	3	1	2			1					2	3	2
CO-3	2	3	1	2			1					2	3	2
CO-4	2	3	2	2			1					2	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Theory of Target Detection: Noise and false alarms, Detection of one sample of 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.	**9**
Module-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.	**9**

	Tracking Radar: Different types of tracking techniques, tracking in range, Tracking in Doppler, Search Acquisition radar, Comparison of Trackers.	
Module-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**

Learning Resources:	
Text Books:	David Barton. K,Modern Radar System Analysis Fred Nathanson E,Radar Design Principles Signal Processing and The Environment
Reference Books:	Cook CE. Bernfield. M, Radar Signals
Other Suggested Readings:	

Course Title:	**ADVANCE NEURAL NETWORK**
Course Code:	**PEVL 612**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Data Structure and Programming (CSVB 306), Algorithm for VLSI Design (ECVB 514)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the concept of neurons and human brain in neural network	Understand (Level-II)
CO-2	Analyze the error corrections and filtering techniques for neural network	Analyze (Level-IV)
CO-3	Apply the back propagation algorithm in neural networks	Apply (Level-III)
CO-4	Apply the feature mapping techniques for various models	Apply (Level-III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1			1					2	3	2
CO-2	1	3	2	1			1					2	3	2
CO-3	1	2	3	2	1		1					3	3	2
CO-4	1	2	3	3	1		1					3	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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.	**09**
Module-II	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	**09**
Module-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,	**09**

	Network pruning Techniques, Virtues and limitations of back propagation learning, accelerated convergence, supervised learning.	
Module-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.	**09**

Learning Resources:

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 Title:	**VLSI Interconnects**
Course Code:	**PEVL 613**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Micro Fabrication Technology (ECVB 405), Digital System Design (ECVB 406), Microprocessors and Microcontrollers (ECVB 408), Digital VLSI Design (ECVB 512)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand the basic interconnect parameters and its model	Understand (Level-II)
CO-2	To study different scaling issues in interconnects.	Apply (Level-III)
CO-3	To analyse theoretical and device level modelling of crosstalk.	Analyze (Level-IV)
CO-4	To learn the repeater interconnects technique. design methods and various advanced	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1				1					1	3	2
CO-2	1	3	1				1					2	3	2
CO-3	1	2	3	2	1		1					2	3	2
CO-4	2	3	1	1			1					3	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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.	**09**
Module-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.	**09**
Module-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,	**09**

	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.	
Module-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.	**09**

Learning Resources:

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 Title:	**AI AND MACHINE LEARNING FOR IC**
Course Code:	**PEVL 614**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Probability Theory and Stochastic Process (MAVL 205)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Introduce the fundamentals of AI, problem-solving, and basic search strategies.	Remember (Level-I)
CO-2	Understand various AI search algorithms.	Analyze (Level-IV)
CO-3	Introduce the fundamentals of machine learning, explore supervised learning techniques	Apply (Level-III)
CO-4	Explore unsupervised learning techniques and introduce the fundamentals of reinforcement learning	Apply (Level-III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1				1					2	3	2
CO-2	1	3	1				1					2	3	2
CO-3	1	2	3	2	1		1					3	3	2
CO-4	1	2	3	3	1		1					3	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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)	**09**
Module-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 Logic, Forward Chaining and Backward Chaining, Introduction to Probabilistic Reasoning, Bayes Theorem.	**09**
Module-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.	**09**

	Classification: – support vector machines (SVM), Naïve Bayes classification	
Module-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	**09**

Learning Resources:

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 Title:	**VLSI FOR COMMUNICATIONS**
Course Code:	**PEVL 615**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Micro Fabrication Technology (ECVB 405), Digital System Design (ECVB 406), Microprocessors and Microcontrollers (ECVB 408), Analog Communication (ECVB 407), Digital Communication (ECVB 511), Digital VLSI Design (ECVB 512)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the concept of communication in VLSI. Understand the High Frequency model of MOS and importance of Impedance Matching.	Understand (Level-II)
CO-2	Analyse the various transceiver and radio architectures.	Apply (Level-III)
CO-3	Design Low Noise amplifiers and Mixers with specifications	Evaluate (Level-V)
CO-4	Realize Oscillators and Frequency synthesizers and their applications to transceiver design.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1			1			1		2	3	2
CO-2	1	3	1				1			2		2	3	2
CO-3	1	2	3	2	1		1			2		3	3	2
CO-4	1	2	3	3	1		1			2		3	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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.	**09**
Module-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: Heterodyne - Homodyne, Image-reject, Direct-IF and subsampled receivers - Direct Conversion and two steps transmitters.	**09**
Module-III	**Low Noise Amplifiers and Mixers:** Low Noise Amplifiers: Common Source LNA - Common Gate LNA -Cascode LNA. Mixers: Design of Active and Passive Mixers.	**09**

Module-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.	**09**

Learning Resources:

Text Books:

Title	RF Microelectronics
Author	B.Razavi
Publisher	Pearson Education Limited
Edition	Second Edition.2013
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

Other Suggested Readings:

1: Leung B. VLSI for wireless communication. Springer Science & Business Media; 2011 Nov 5.

2: Mortara A, Vittoz EA, Venier P. A communication scheme for analog VLSI perceptive systems. IEEE Journal of Solid-State Circuits. 1995 Jun;30(6):660-9.

Course Title:	**MEMORY DEVICES AND CIRCUITS**
Course Code:	**PEVL 616**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital System Design (ECVB 406), Microprocessors and Microcontrollers (ECVB 408)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Acquaint the students with memory cell devices	Understand (Level-II)
CO-2	Analyze the read write operation in memory peripherals, novel SRAM cell	Apply (Level-III)
CO-3	Analyze the read write operation of DRAM cell	Apply (Level-III)
CO-4	Analyze the read/write/hold operations of different memory structures using CAD tools	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1			1			1		1	3	2
CO-2	1	3	2	1			1			1		2	3	2
CO-3	1	2	3	2	1		1			1		2	3	2
CO-4	1	2	3	3	1		1			2		3	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Overview of volatile memory, Non-volatile memory, On-chip memory, On chip memory types.	**09**
Module-II	Review of CMOS circuit design, sensing circuitry basics, Read/write assist circuitry and other peripheral circuitries, Next generation SRAM cell.	**09**
Module-III	Introduction to DRAM, High speed DRAM architectures, Open and folded arrays organizations, Bandwidth, latency, and Cycle time, Power, Timing circuits.	**09**
Module-IV	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	**09**

<table>
<tr><td colspan="3">Learning Resources:</td></tr>
<tr><td>Text Books:</td><td>Title</td><td>Semiconductor Memory Devices and Circuits</td></tr>
<tr><td></td><td>Author</td><td>Shimeng Yu</td></tr>
<tr><td></td><td>Publisher</td><td>CRC Press</td></tr>
<tr><td></td><td>Edition</td><td>1st edition</td></tr>
<tr><td></td><td>Title</td><td>Memory Devices</td></tr>
<tr><td></td><td>Author</td><td>David R. Coelho</td></tr>
<tr><td></td><td>Publisher</td><td>Kluwer Academic Publishers, Springer</td></tr>
<tr><td></td><td>Edition</td><td>1989</td></tr>
<tr><td>Reference Books:</td><td>1:Title</td><td>CMOS memory circuits</td></tr>
<tr><td></td><td>Author</td><td>Haraszti TP.</td></tr>
<tr><td></td><td>Publisher</td><td>Springer Science & Business Media</td></tr>
<tr><td></td><td>Edition</td><td>2000 Sep 30</td></tr>
<tr><td>Other Suggested Readings:</td><td colspan="2">1: Sebastian A, Le Gallo M, Khaddam-Aljameh R, Eleftheriou E. Memory devices and applications for in-memory computing. Nature nanotechnology. 2020 Jul 2;15(7):529-44.
2: Ielmini D, Pedretti G. Device and circuit architectures for in-memory computing. Advanced Intelligent Systems. 2020 Jul;2(7):2000040.</td></tr>
</table>

Bouquet 3: Elective-IV and Elective V

Course Title:	**CAD FOR VLSI**
Course Code:	**PEVL 717**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital VLSI Design (ECVB 512), Analog VLSI Design (ECVB 618)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the fundamentals of Computer-Aided Design (CAD) tools for the design, analysis.	Understand (Level-II)
CO-2	Analyze with Computer-Aided Design (CAD) to perform synthesis, test and verification.	Analyze (Level-IV)
CO-3	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)
CO-4	Create the mini project work with Computer-Aided Design (CAD) tool	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1				1				2	2	1
CO-2	3	2	1	1				1				2	2	1
CO-3	3	2	2	3				1				2	3	2
CO-4	3	2	2	2				1				2	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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 sequential circuits.	**9**
Module-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**
Module-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**

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

Course Title:	**THIN FILM CHARACTERIZATION**
Course Code:	**PEVL 718**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Micro Fabrication Technology (ECVB 405), Analog VLSI Design (ECVB 618)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand the kinetics and growth of thin film.	Understand (Level-II)
CO-2	Analyse the growth techniques, measurements and property of thin films.	Analyze (Level-IV)
CO-3	Analyse the diffusion process in thin films.	Evaluate (Level-VI)
CO-4	To characterise the thin film and analyse the coating mechanism.	Evaluate (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1					1				1	2	1
CO-2	3	1	1					1				1	2	1
CO-3	3	2	1					1				1	2	1
CO-4	3	1	2					1				1	2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

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

Learning Resources:

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

Course Title:	**MIXED-SIGNAL IC DESIGN**
Course Code:	**PEVL 719**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital VLSI Design (ECVB 512), Analog VLSI Design (ECVB 618)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understanding of metal-oxide-semiconductor field-effect transistors and relationship of process technology with models used for analog IC.	Understand (Level-II)
CO-2	Analyse the CMOS digital circuits operation.	Analyze (Level-IV)
CO-3	Evaluate the complex, non-digital behaviour of the devices and circuits with which digital systems are implemented.	Evaluate (Level-V)
CO-4	Explain the circuit design, optimization, and layouts.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1								1	1	1
CO-2	3	2	2	1								1	1	1
CO-3	2	2	3	2								1	2	2
CO-4	2	2	3	3								1	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Frequency compensation schemes: Miller compensation, Ahuja compensation and Nested Miller compensation.	**9**
Module-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**
Module-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**

Learning Resources:

Text Books:	**1. "Analog MOS integrated circuits for signal processing" by R. Gregorian and Temes, Wiely, 2008.** **2. "Introduction to CMOS opamps and comparators" by R. Gregorian, Wiely interscience, 1999.**
Reference Books:	**"Analog integrated circuit design" by D.Johns and K.Martin, Wiely 2008**
Other Suggested Readings:	

Course Title:	**BIO-MEDICAL ELECTRONICS**
Course Code:	**PEVL 720**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Digital Electronics (ECVB 304)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Demonstrate standard tests, measurements, and experiments and to analyse and interpret the result to improve processes.	Understand (Level-II)
CO-2	Develop knowledge about different types of Electrodes, Transducers, and Amplifiers.	Apply (Level-III)
CO-3	Examine the important and modern methods of imaging techniques.	Analyze (Level-IV)
CO-4	Apply the electronics fundamentals for bio-medical application.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	1	1				1				2	2	1
CO-2	2	2	1	1				1				2	2	1
CO-3	2	2	2	3				1				2	2	1
CO-4	2	2	2	3				1				2	2	1

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Bioelectric Amplifiers: Signal Processing Circuits, Practical Op-Amps, and 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.	**9**
Module-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**

Module-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**

Learning Resources:

Text Books:	1. "Handbook of Biomedical Instrumentation" by R.S. Khandpur, Tata McGraw-Hill, 2nd Edition, 2003. 2. "Introduction to Biomedical Equipment and Technology" by J. Carr Joseph and John M. Brown, Prentice-Hall, New Jersey, 4th edition. 2001
Reference Books:	"3-D Bioprinting Revolution" by Sabrie Soloman, Khanna Publishing House, 2020
Other Suggested Readings:	

Course Title:	**RF MICROELECTRONICS**
Course Code:	**PEVL 721**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Analog VLSI Design (ECVB 618)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Interpret RF frequency response of MOSFET.	Understand (Level-II)
CO-2	Construct the RF technology and basic concepts in RF design.	Apply (Level-III)
CO-3	Analyse communication concepts in transceiver architectures.	Analyze (Level-IV)
CO-4	Evaluate basic blocks in RF systems such as LNA, Mixer and VCO.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	2								1	1	2
CO-2	3	1	1	2								1	1	2
CO-3	3	1	1	1								1	1	2
CO-4	3	1	2	1								1	1	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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 (gm), output conductance (gds), small-signal output resistance (ro), A Medium-Frequency Small-Signal Model for the Intrinsic Part, Intrinsic Transition Frequency, Noise in MOSFET: white noise, flicker noise, High frequency Small Signal Model, Transition Frequency (fT) and Maximum oscillation (fmax) of MOSFET.	**9**
Module-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**
Module-III	Analog modulation, Digital modulation, Spectral Regrowth, Mobile RF Communications, Multiple Access techniques Wireless standards; Receiver Architectures: Basic Heterodyne	**9**

	Receivers, Modern Heterodyne Receivers, Direct-Conversion Receivers, Image Reject Receivers, Low-IF Receivers; Transmitter Architectures: Direct-Conversion Transmitters, Modern Direct-Conversion Transmitters, Heterodyne Transmitters.	
Module-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 trade-off. Resonator less VCO design; Quadrature and single-sideband generators.	**9**

Learning Resources:

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

Course Title:	**HIGH SPEED INTERFACING CIRCUITS**
Course Code:	**PEVL 722**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the basic features and needs for clocking styles.	Understand (Level-II)
CO-2	Develop a good understanding in the advanced clock logic styles and its applications	Apply (Level-III)
CO-3	Develop a good proficiency in the different non-clocking logic styles.	Apply (Level-III)
CO-4	Evaluate the working of different latching strategies.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	1								2	1	2
CO-2	3	1	1	1								2	1	2
CO-3	3	1	2	1								2	1	2
CO-4	3	2	2	1								2	1	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Latched domino structures, sample-set differential logic, Enable/disable CMOS differential logic, Latch domino, Differential current switch logic, switched output differential structure, clocked pass-gate logic, dynamic complementary pass gate logic.	**9**
Module-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**
Module-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**

Learning Resources:

Text Books:	1. "High Speed CMOS Design Styles" by Bernstein, Keith M. Carrig, Kluwer Academic Publishers, 2002. 2. "Logical Efforts, Designing Fast CMOS Circuits" by Evan Sutherland, Bob Stroll, David Harris, Kluwer Academic Publishers, 1999.
Reference Books:	"Skew Tolerant Domino Design" by David Harris, IEEE Journal of Solid- State Circuits, 2001.
Other Suggested Readings:	

Course Title:	**DIGITAL IMAGE PROCESSING**
Course Code:	**PEVL 723**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Signals and Systems (ECVB 303), Digital Signal Processing (ECVB 409)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Analyze images in the frequency domain using various transforms.	Analyze (Level-IV)
CO-2	Evaluate the techniques for image enhancement and image restoration.	Evaluate (Level-V)
CO-3	Categorize various compression techniques.	Analyze (Level-IV)
CO-4	Interpret Image compression standards, segmentation and representation techniques.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	2								2	1	1
CO-2	3	1	2	2								2	1	1
CO-3	3	2	2	2								2	2	2
CO-4	3	2	2	2								2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-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**

Module-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**

Learning Resources:

Text Books:	1. "Digital Image Processing" by R. C. Gonzalez and R. E. Woods, Pearson Education, Third edition, 2009. 2. "Fundamental of Digital Image Processing" Anil K Jain, Prentice Hall, 1989
Reference Books:	"The essential guide to image processing" by A. C. Bovik, Academic Press, Second edition 2009
Other Suggested Readings:	

Course Title:	**FLEXIBLE ELECTRONICS**
Course Code:	**PEVL 724**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Micro Fabrication Technology (ECVB 405)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Summarize the advantages, drawbacks, performances, complementarity, and uniqueness of large area manufacturing vs. silicon technology.	Understand (Level-II)
CO-2	Develop the operation principles, architectures, and processing of main devices and systems fabricated for flexible electronics.	Apply (Level-III)
CO-3	Analyse the concept of thin film electronics.	Analyze (Level-IV)
CO-4	Elaborate systems integration issues and propose methods for integration and encapsulation of printed devices and systems.	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	1								1	1	2
CO-2	3	2	1	1								1	1	2
CO-3	3	2	2	2								1	1	2
CO-4	3	2	2	2								1	1	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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 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.	**9**
Module-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,	**9**

	electrolyte gated, Case studies; sub micrometer OTFTs and gravure printed OTFTs, From transistors to circuits.	
Module-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**

Learning Resources:

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

Course Title:	**QUANTUM COMPUTING**
Course Code:	**PEVL 725**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Engineering Physics (PHVB 204)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Demonstrate the framework of quantum computation.	Understand (Level-II)
CO-2	Utilize the framework to look how that may be useful for future quantum technologies.	Apply (Level-III)
CO-3	Analyse the basics of quantum computing.	Analyze (Level-IV)
CO-4	Apply the quantum circuits for error control.	Apply (Level-III)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1				1				2	2	1
CO-2	2	2	2	1				1				2	2	1
CO-3	3	2	2	3				3				2	3	2
CO-4	2	2	2	2				1				2	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Review of Quantum Mechanics and Motivation for Quantum Computation Qubit: The qubit state - matrix and Bloch sphere representation - computational basis unitary evolution.	**9**
Module-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 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.	**9**
Module-III	Quantum computing: Classical computing using qubits - Quantum parallelism - Deutsch's algorithm -Deutsch Josza algorithm.	**9**
Module-IV	Quantum circuits: Basic gates - ABC decomposition - Gray codes - Universal gates - Principle of deferred and implicit measurements - Quantum Fourier transform - applications:	**9**

	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.	

Learning Resources:		
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 Title:	**Solar Cell Technology**
Course Code:	**PEVL 726**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302)**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the principles and arrangements of silicon atoms and p-n junction for illumination	Understand (Level-II)
CO-2	Apply knowledge on solar cell parameters for efficient design	Apply (Level-III)
CO-3	Analyse the growth process of metallurgical and electronic grade silicon	Analyze (Level-IV)
CO-4	Develop the knowledge of solar cell technology for development of commercial solar cell	Create (Level-VI)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1	2	1	3				1				1	2	3
CO-2	2	2	3	1				2				1	2	1
CO-3	2	2	2	3				3				1	3	2
CO-4	2	2	2	2				1				1	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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;	**9**

	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.	
Module-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**
Module-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**

Learning Resources:		
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 Title:	**ADHOC SENSOR NETWORKS**
Course Code:	**PEVL 727**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Network Analysis and Control Theory (EEVL 305)**

Course Outcomes:

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)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1	3	1	2				2				1	2	3
CO-2	2	1	3	3				2				1	2	2
CO-3	2	3	2	2				3				1	1	2
CO-4	2	2	2	2				1				1	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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. 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	**9**
Module-II	Transport layer & Security protocols: Issues in designing transport layer protocols, TCP over Ad Hoc Wireless Networks, Network Security Attacks, and Key management.	**9**
Module-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**
Module-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	**9**

	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	

Learning Resources:

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 Title:	**FULL CUSTOM DESIGN**
Course Code:	**PEVL 728**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Digital VLSI Design (ECVB 512)**

Course Outcomes:

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)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	1			2	1				2	2	3
CO-2	1	1	2	1			2	1				1	3	1
CO-3	3	3	2	3			2	3				2	3	2
CO-4	3	2	2	2			2	1				2	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-III	**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.	**9**
Module-IV	**Proper layout:** CAD tools for layout, planning tools, Layout generation tools, Support tools. Analog layout concepts.	**9**

Learning Resources:

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

Course Title:	**ADVANCED SEMICONDUCTOR MANUFACTURING**
Course Code:	**PEVL 729**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Electronic Devices and Circuits (ECVB 302), Semiconductor Packaging and Testing (ECVB 513)**

Course Outcomes:

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)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	1	2		2	2	1				1	2	2
CO-2	1	1	3	1		1	2	1				1	2	1
CO-3	3	3	2	3		2	2	3				2	3	2
CO-4	3	2	2	2		1	2	1				2	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Overview of semiconductor manufacturing and its significance, Historical context and evolution of semiconductor manufacturing technologies., Introduction to advanced processes and equipment.	**9**
Module-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**
Module-III	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	**9**
Module-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**

Learning Resources:		
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 Title:	**DATA CONVERTERS**
Course Code:	**PEVL 730**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	

Course Outcomes:

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)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**2**	**2**	**1**				**2**				**2**	**3**	**1**
CO-2	**2**	**2**	**1**	**1**				**1**				**2**	**2**	**2**
CO-3	**3**	**2**	**3**	**3**				**3**				**2**	**3**	**2**
CO-4	**2**	**3**	**1**	**2**				**1**				**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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	**9**
Module-II	Current Steering DACs, current cell design issues. Properties of MOS Switches, charge injection, bootstrapping, sampling jitter, thermal noise, Quantization noise and nonlinearity effects	**9**
Module-III	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.	**9**
Module-IV	Delta sigma modulators, alternative modulator architectures, quantization and noise shaping, decimation filtering, implementation of Delta sigma modulators, delta sigma DACs.	**9**

Learning Resources:

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 Title:	**RECONFIGURABLE COMPUTING SYSTEM AND APPLICATION**
Course Code:	**PEVL 731**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**Problem Solving and Computer Programming (CSVB 204), Algorithm for VLSI Design (ECVB 514)**

Course Outcomes:

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)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	1				2				1	2	1
CO-2	2	3	2	1				1				2	2	1
CO-3	3	2	2	2				3				2	3	2
CO-4	2	2	2	2				1				1	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to Reconfigurable Computing Systems Evolution and Characteristics of Reconfigurable Systems Advantages and Challenges in Reconfigurable Computing	**9**
Module-II	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	**9**
Module-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	**9**
Module-IV	Implementing Applications with FPGAs-Precision Analysis for Fixed-point Computation-Distributed Arithmetic-CORDIC	**9**

	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)	

Learning Resources:

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

LIST OF OPEN ELECTIVES

Open Elective-I

Course Title:	**GROWTH, FABRICATION AND MANUFACTURING OF ELECTRONIC DEVICES**
Course Code:	**OEVL 601**
L-T-P:	**3–0–0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To Understand the characterization techniques and design flow of IC technology.	Understand (Level-II)
CO-2	To Analyse the monolithic fabrication techniques and monolithic components in different transistors.	Analyze (Level-IV)
CO-3	To Examine the Assembly and packaging of the VLSI Devices.	Apply (Level-III)
CO-4	Explore the modern processing techniques in VLSI device fabrication.	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓							✓	✓	✓				
CO-2	✓	✓	✓											
CO-3	✓				✓	✓						✓	✓	✓
CO-4	✓				✓	✓						✓	✓	✓

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	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.	**9**
Module-III	Assembly Techniques & Packaging of VLSI Devices: Introduction to packaging, Package design considerations, VLSI Assembly	**9**

	techniques, Packaging fabrication technology. Surface Mount Technology (SMT): Through hole technology, Surface Mount Technology, applications & SM Components.	
Module-IV	Special Techniques for Modern Processes: Self-aligned silicides, hallow junction formation, nitride oxides etc. process flows for CMOS and bipolar IC processes.	**9**

Learning Resources:	
Text Books:	1- "VLSI Technology" by S.M. Sze, Tata McGraw Hill, 1983. 2- "Introduction to VLSI" by Eshraghian and Pucknell, Tata McGraw-Hill, 2007.
Reference Books:	1-"VLSI Fabrication Principles" by S.K. Gandhi, 2nd Edition, Wiley-Blackwell, 1994.
Other Suggested Readings:	NPTEL Lectures.

Course Title:	**ELECTRONIC MATERIALS**
Course Code:	**OEVL 602**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	Understand the synthesis and properties of nanomaterials.	Understand (Level-II)
CO-2	Analyse modelling of composite materials by finite element analysis.	Analyze (Level-IV)
CO-3	Differentiate superconducting materials.	Apply (Level-III)
CO-4	Understand the characteristics and uses of functional materials.	Understand (Level-II)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓	✓	✓	✓							✓			
CO-2	✓	✓	✓	✓						✓	✓			
CO-3	✓	✓	✓	✓							✓			
CO-4	✓	✓	✓	✓							✓			

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-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**

Module-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**

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

Course Title:	**BASICS OF IC DESIGN**
Course Code:	**OEVL 603**
L-T-P:	**3–0–0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO-1	To understand the MOSFET operation their internal characteristics.	Understand (Level-II)
CO-2	To study amplifiers and their classifications.	Apply (Level-III)
CO-3	To analyse CMOS circuits and application in memory design.	Understand (Level-II)
CO-4	To enhance knowledge in DRAM Cell.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓													
CO-2	✓		✓											
CO-3	✓		✓		✓			✓	✓			✓	✓	✓
CO-4	✓				✓			✓	✓			✓	✓	✓

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-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**
Module-III	Basics of CMOS circuit design, sensing circuitry basics, Read/write assist circuitry and other peripheral circuitries, Next generation SRAM cell.	**9**

Module-IV	Introduction to DRAM, High speed DRAM architectures, Open and folded arrays organizations, Bandwidth, latency, and Cycle time, Power, Timing circuits.	**9**

Learning Resources:	
Text Books:	1- "Data and Computer Communications" by William Stallings, 10th Edition, Pearson. 2- "Computer Networks" by A.S. Tanenbaum and D.J. Wetherall, 5th Edition, Prentice-Hall, 2010.
Reference Books:	1- "Data Communication and Networking" by Behrouz A. Forouzan, 5th Edition, McGraw Hill, 2012.
Other Suggested Readings:	NPTEL Lectures.

Course Title:	**STANDARDIZATION AND QUALITY ECOSYSTEM**
Course Code:	**OEVL 604**
L-T-P:	**3-0-0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To understand the clean room technology and basic fabrication process flow of semiconductor devices.	Remembering/Understanding (Level-I/Level-II)
CO-2	To implement digital circuits such as CMOS inverter, Pseudo NMOS, DCVS, Domino etc.	Application (Level-III)
CO-3	To design the layout and stick diagram of various logic gates.	Analysis (Level-IV)
CO-4	To evaluate the static and dynamic switching characteristics of CMOS inverter.	Evaluation (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	**3**	**1**	**1**	**1**								**2**	**1**	**2**
CO-2	**3**	**1**	**1**	**1**								**2**	**1**	**2**
CO-3	**3**	**1**	**2**	**2**								**2**	**1**	**2**
CO-4	**3**	**1**	**2**	**2**								**2**	**1**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	**Accreditation & International Standardization Bodies** • International Accreditation Forum (IAF) – Introduction and Structure • ISO/IEC 17011 -Conformity assessment — Requirements for accreditation bodies accrediting conformity assessment bodies • ISO (International Organization for Standardization) • IEC (International Electrotechnical Commission) • ITU (International Telecommunication Union) Regional Standardization	**01**
Module-II	**Quality Council of India (QCI) and Bureau of Indian Standards (BIS)** • Introduction and Role of QCI • Boards/Divisions under QCI • Overview of BIS and its activities Organizational Structure and Goals of BIS	**02**
Module-III	**Basic Concepts of Standardization** • What is a STANDARD? • Need, Aims and Benefits of Standards	**03**

	• Types of Standards • What is STANDARDIZATION? History of Standardization – international level and national level	
Module-IV	**Laboratory Operations at BIS** • Basics of Laboratory Operations • Role of Labs in conformity assessment • BIS Testing Labs • Inter Laboratory Comparison and Proficiency Testing Concept of 'One Nation One Standard' and Standard Developing Organization (SDO)	**04**
Module-V	**Overview of Conformity Assessment in BIS** • What is CERTIFICATION? • Key Pillars of Certification • BIS Conformity Assessment Legal Framework • Overview of BIS Conformity Assessment Schemes • Voluntary and Mandatory Certification • Product Certification Schemes Foreign Manufacturer's Certification Scheme	**05**
Module-VI	**Addressing Sustainability Through Standards** • Concept of Sustainability • Need for Sustainability and Role of Standards • United Nations Sustainable Development Goals (UN SDGs) • ISO Guidelines for Addressing Sustainability and Climate Change in Standards • Consultative Groups on Sustainability Approach to address Sustainability in Standards	**06**
Module-VII	**BIS – Academia Collaboration** • Research-based standardization - R&D Projects and Action Research Projects • Annual Programme for Standardization • Standardization Cells • State-Level Committee on Standardization (SLCS) • Partnering with Academic Institutes • Manak Manthan and Manak Mantrana • Importance of concepts on standards for students • Role of Faculty and Research Scholars in Standardization and Quality Ecosystem of the country Training and Capacity Building	**07**
Module-VIII	**In these lectures, the important standards, their requirement and development procedures will be discussed** Students can select one of the sections mentioned below according to his/her background/branch and choice SECTION I - Chemical, Environment and Ecology, Food and Agriculture, Petroleum, Coal and Related Products SECTION II - Electronics and Information Technology, Medical Equipment, Electrical, AI and Computer Science SECTION III- Civil, Structure, Building, Water Resources and Transport SECTION IV – Mechanical, Metallurgical, Production and General Engineering SECTION V- Service Sector, Management and Systems	**08-11**

Module-IX	Exercise on the drafting of Indian Standard as per IS 12 - Guide for Drafting and Presentation of Indian Standards, Workshop/Assignment	**12-13**

Learning Resources:

Text Books:	1. ISO Standards Handbook, International Organization for Standardization. 2. Alan Bryden and Dr. Samad El-Hout, Conformity Assessment: Fundamentals and Practices.
Reference Books:	3. Russell, J.P. The ISO 9001-2015 Handbook 4. Jacobson Kai, The Role of Standards in Today's Society and in the future. 5. John. G. Keogh, Hakan Anderson, International Conformity Assessment: Current Practices and Future Directions. 6. BIS Standards catalogue by Bureau of Indian Standards. 7. ISO/IEC 17000: Conformity Assessment -Vocabulary and General Principles.
Other Suggested Readings:	

Open Elective-II

Course Title:	**DATA COMMUNICATION AND NETWORKING**
Course Code:	**OEVL 704**
L-T-P:	**3-0-2**
Credits:	**3**
Pre-requisites:	

Course Outcomes:

Course Outcomes:		**Cognitive Levels**
CO1	To understand overview of data communication and networking aspect.	Remembering/ Understanding (Level-I/Level-II)
CO2	To apply various multiple access techniques to understand the modern communication methodologies	Application (Level-III)
CO3	To analyse the different routing algorithms needed.	Analysis (Level-IV)
CO4	To evaluate the different protocols used in transport and application layer.	Evaluation (Level-V)

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	2	2	2	3	2					3			3	3
CO-2	3	2	2	3	3					2			2	3
CO-3	2	2	3	3	2					2			3	2
CO-4	2	2	3	2	2					2			2	3

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-I	Introduction to data communication and networking: Why study data communication? Data Communication, Networks, Protocols and Standards, Standards Organizations. Line Configuration, Topology, and 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)	**8**
Module-II	Study of Signals: Analog and Digital, Periodic and Aperiodic Signals, Analog Signals, Time and Frequency Domains, Composite Signals, Digital Signals, **Physical layer**: line encoding, block encoding, scrambling, and Different types of 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.	**8**

Module-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.	**8**
Module-IV	**Network layer**: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Supernetting, Classless addressing, Network Address Translation. Introduction to 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,	**12**

Learning Resources:

1.	Title	Data and Computer Communications
	Author	William Stallings
	Publisher	Pearson
	Edition	TENTH EDITION
2.	Title	Computer Networks
	Author	AS Tanenbaum, DJ Wetherall
	Publisher	Prentice-Hall
	Edition	5th Edition, 2010
3.	Title	Data Communication and Network
	Author	Behrouz A. Forouzan
	Publisher	McGraw Hill
	Edition	5th Edition, 2012

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Reference Books, Journals, Reports, Websites etc. in the IEEE format)
Data Communications and Networking - Behrouz A. Forouzan, Fifth Edition TMH, 2013.
Data Communication & Networking by Forouzan, Tata McGraw Hill
Kurose and Ross, "Computer Networking- A Top-Down Approach", Pearson.
Computer Network, 4e, by Andrew S. Tenenbaum, Pearson Education/ PHI.

Course Title:	**MICRO-ELECTRONICS AND VLSI TECHNOLOGY**
Course Code:	**OEVL 705**
L-T-P:	**3–0–0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	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)
CO-2	To develop skills for simulating the various fabrication processes.	Apply (Level-III)
CO-3	To understand the process integration flow for different IC fabrication technologies	Understand (Level-II)
CO-4	Examine the current developments in VLSI technology.	Analyze (Level-IV)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓	✓	✓	✓							✓			
CO-2	✓	✓	✓	✓				✓				✓		
CO-3	✓	✓	✓	✓		✓		✓		✓				
CO-4	✓	✓	✓	✓					✓					

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Process simulation, Introduction, Ion-implantation, Monte Carlo method, Diffusion and Oxidation, two-dimensional LOCOS simulation example, Epitaxy, Epitaxial doping model, Lithography, Optical projection lithography, Electron-beam lithography, Etching and deposition, future trends.	**9**
Module-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**

Module-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**

Learning Resources:

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

Course Title:	**EMBEDDED AND REAL TIME OPERATING SYSTEMS**
Course Code:	**OEVL 706**
L-T-P:	**3–0–0**
Credits:	**3**
Pre-requisites:	**NA**

Course Outcomes:

Course Outcomes		**Cognitive Levels**
CO-1	To Understand the Real-Life applications of Embedded System, Real time operating Systems (RTOS).	Understand (Level-II)
CO-2	To Analyze the Task states and scheduling, Task Operations, Semaphores and Message Queues.	Analyze (Level-IV)
CO-3	To Analyze the kernel objects in RTOS Services, Timer and Timer Services, I/O Subsystems.	Analyze (Level-IV)
CO-4	Evaluate the Memory Management, Synchronization and Communication, Deadlocks	Evaluate (Level-V)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	✓			✓			✓			✓	✓		✓	
CO-2			✓				✓			✓		✓		✓
CO-3			✓	✓		✓			✓				✓	
CO-4			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:		
Module	**Detailed Syllabus**	**Contact Hours**
Module-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**
Module-II	Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use.	**9**
Module-III	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.	**9**
Module-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**

Learning Resources:

Text Books:	1) Real Time Concepts for Embedded Systems Qing Li, Elsevier, 2011 2) Embedded Systems- Architecture, Programming and Design, Rajkamal, TMH, 2007
Reference Books:	Embedded Linux: Hardware, Software and Interfacing Dr. Craig Hollabaugh Addison-Wesley Professional 2002