Master of Technology
(Electronics & Communication Engineering)

Scheme & Syllabus
(III Sem & IV Sem)
w.e.f. 2021-22

Department of Electronics & Communication Engg.

Guru Jambheshwar University of Science & Technology
HISAR-125001, Haryana

M.Tech (ECE)

Program Outcomes and Program Specific Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PSO1: Students should be able to develop advanced understanding of the concepts of Electronics & communication engineering and their applications in the specific areas of VLSI, Communication Engineering and signal processing.

PSO2: Students should have an ability to apply technical knowledge of modern hardware & software tools for the design of electronic subsystems for solving various engineering problems.

Semester	Total Credits
I	26
II	22
III	14
IV	08
Total	70

- 04 contact hours per week are required for each theory subject including electives. However, 03 contact hours per week are required for open elective subject.
- 04 contact hours per week are required for each laboratory course.
- 02 hrs per student per week teaching load will be assigned to supervisor for dissertation work for Part I and Part II each.

M. Tech. (ECE), 3rd Semester										
Sr. No.	**Course Code**	**Course Title**	**Teaching Schedule (Hrs/week)** L P T			**Credit**	**Exam Duration (Hr)**	**Internal Marks**	**External Marks**	**Total Marks**
1	ECL-731(x)	Elective-II	3	0	0	3	3	30	70	100
2	3OExx	Elective-III (Open Elective)	3	0	0	3	3	30	70	100
3	ECP-732	Advanced VLSI Design Lab	0	0	4	2	3	30	70	100
4	ECP-733	Communication System Design Lab	0	0	4	2	3	30	70	100
5	ECD-730	Dissertation-Part I	0	0	*	3	-	100	-	100
6	ECP-735	Seminar	0	0	2	1	-	100	-	100
		Total	**6**	**0**	**10**	**14**		320	280	600

*02 hrs per student per week teaching load will be assigned to supervisor for Dissertation - Part I.

List of Elective-II (3rd Semester)

The student can opt for any one subject from the following list.

Sr. No.	Course Code	Course Title
1	ECL-731(i)	Mixed Signal Design
2	ECL-731(ii)	RF Micro-electronics
3	ECL-731(iii)	VLSI Testing and Testability
4	ECL-731(iv)	Memory System Design
5	ECL-731(v)	Low Power VLSI Design
6	ECL-731(vi)	Wireless Sensor Networks

7	ECL-731(vii)	Advanced Digital Communication
8	ECL-731(viii)	Satellite Communication
9	ECL-731(ix)	FPGA Design
10	ECL-731(x)	Advanced Antenna Theory and Design

List of Elective-III (Open Electives)

The student can opt for any one subject from the following list:

Sr. No.	Course Code	Course Title
1	3OE01	Business Analytics
2	3OE02	Industrial Safety
3	3OE03	Operations Research
4	3OE04	Cost Management of Engineering Projects
5	3OE05	Composite Materials
6	3OE06	Waste to Energy
7	3OE07	Advanced Communication Systems
8	3OE08	Introduction to Soft Computing Techniques
9	3OE09	Advanced Printing Technology
10	3OE10	Computer Aided Design & Manufacturing
11	3OE11	Food Safety and Quality Assurance

M. Tech. (ECE), 4th Semester										
Sr. No.	**Course Code**	**Course Title**	**Teaching Schedule (Hrs/week)**			**Credit**	**Exam Duration (Hr)**	**Internal Marks**	**External Marks**	**Total Marks**
			L	**T**	**P**					
I	ECD-740	Dissertation - Part II	0	0	*	8	-	-	100	100
		Total	**0**	**0**	**-**	**8**		**-**	**100**	**100**

*02 hrs per student per week teaching load will be assigned to supervisor for Dissertation - Part II.

Third Semester

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINNERING

Mixed-Signal Design

ECL-731 (i)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Digital System Design, Analog IC Design

Course Objectives: The course provides an overview of Mixed Signal CMOS VLSI Design, particularly signals, data converters and deals with both the function of related components and system performance. The classification of various filters, data converts with practical implementation are demonstrated using characterizing parameters.

Course Outcomes:

Sr. No.	At the end of the semester, Student will be able to	RBT Level
CO 1	**Describe** CMOS analog and digital mixed signal circuits and systems and their technical specifications and uses.	LOTS: Level 1 Remember
CO 2	**Understand** various CMOS analog and digital mixed signal circuits and systems topologies.	LOTS: Level 2 Understand
CO 3	**Apply** the concepts of CMOS analog and digital mixed signal logics for the design of integrated circuits and systems.	LOTS: Level 3 Apply
CO 4	**Analyze** CMOS analog and digital mixed signal circuits and systems.	HOTS: Level 4 Analyze
CO 5	**Evaluate** CMOS analog and digital mixed signal circuits and systems.	HOTS: Level 5 Evaluate
CO 6	**Design** CMOS analog and digital mixed signal circuits and systems for IC design, test and verification.	HOTS: Level 6 Create

Course Contents

UNIT-1

Signals, Filters and Tools-Sinusoidal Signals, Comb Filters, Representing Signals, Exponential Fourier Series, Fourier Transform, Dirac Delta Function, Sampling and Aliasing: Sampling and circuits- Impulse Sampling, The Sample-and-Hold (S/H), S/H Spectral Response and implementation, The Reconstruction Filter, The Track-and-Hold (T/H), Interpolation, Zero Padding, Hold Register, Linear Interpolation, K-Path Sampling, Switched-Capacitor Circuits, Non-Overlapping Clock Generation

UNIT-2

Analog Filters: Integrator Building Blocks: Lowpass Filters, Active-RC Integrators, MOSFET IC Integrators, gm-C (Transconductor-C) Integrators, Common-Mode Feedback Considerations, Discrete-Time Integrators, Exact Frequency Response of an Ideal Discrete-Time Filter, Filtering Topologies: The Bilinear Transfer Function, The Biquadratic Transfer Function, High Q, Q Peaking and Instability

Digital Filters: SPICE Models for DACs and ADCs, The Ideal DAC and AD, Sinc-Shaped Digital Filters, LowpassSinc Filters, Filtering topologies, The Biquadratic Transfer Function, Comparing Biquads to Sinc-Shaped Filters

UNIT-3

Data Converter SNR- Quantization Noise, Quantization Noise Voltage Spectral Density, Calculating Quantization Noise from a SPICE Spectrum, Power Spectral Density, Signal-to-Noise Ratio (SNR): Effective Number of Bits, Coherent Sampling, Signal-to-Noise Plus Distortion Ratio, Spurious Free Dynamic Range, Dynamic Range, Specifying SNR and SNDR, Clock Jitter, Using Oversampling to Reduce Sampling Clock Jitter, Stability Requirements, Improving SNR using Averaging, Ideal Signal-to-Noise Ratio, Linearity requirements. Data Converter Design Basics: The One-Bit ADC and DAC, Improving SNR and Linearity, Revisiting Switched Capacitor Implementations, Improving Linearity Using an Active Circuit.

UNIT-4

Noise-Shaping Data Converters: First-Order Noise Shaping, Second-Order Noise-Shaping, Noise-Shaping Topologies, Bandpass Data Converters: Continuous-Time Bandpass Noise Shaping, Active-Component Bandpass Modulators, Switched-Capacitor Bandpass Noise Shaping, A High-Speed Data Converter: The Topology, Clock Signals, Path Settling Time, Implementation, Filtering, Practical Implementation

Reference Book:

1. R. J. Baker, *"CMOS Mixed Signal Circuit Design"*, Second Edition, John Wiley& Sons, 2011.
2. Handkiewicz, *"Mixed-Signal Systems: A Guide to CMOS Circuit Design"*, First Edition, John Wiley & Sons, 2015.
3. P. V. A. Mohan, V. Ramachandran and M. N. S. Swamy, *"Switched CapacitorFilters: Theory, Analysis and Design"*, Third Edition, PHI, 2014.
4. E. Sanchez-Sinencio and A. G. Andreou, *"Low-Voltage/Low-Power IntegratedCircuits and Systems: Low-Voltage Mixed-Signal Circuits"*, First Edition, John Wiley & Sons, 2015.
5. 4. E. N. Farag and M. I. Elmasry, *"Mixed-Signal VLSI Wireless Design: Circuitsand Systems"*, First Edition, Kluwer Press, 2011.
6. Y. Tsividis, *"Mixed Analog-Digital VLSI Devices and Technology"*, Second Edition, TMH, 2011.

Course Articulation Matrix:

Mixed-Signal Design (ECL-731(i))					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	H	H	H	H	H
CO 2	H	H	H	H	M
CO 3	M	H	H	H	M
CO 4	M	H	M	H	M
CO 5	H	H	H	H	M
CO 6	M	H	M	H	M

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

RF Micro-Electronics
ECL-731 (ii)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Analog Electronics

Course Objectives: This Course is for second-year post-graduate students. The objective of this course is to provide students with an understanding of modern RF electronics devices employed in RF Transceiver Design. This course is aimed to provide the knowledge of various issues encountered in high-frequency circuits, such as impedance matching, realization of passive components and bandwidth enhancement. Design components of radio-frequency systems, including low noise amplifiers, oscillators, mixers and power amplifiers will be discussed in detail. The effect of individual components performance on overall radio-frequency transmitter and receiver design and performance are also covered in this course plan.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to:	RBT Level
CO 1	**Define** the basic terminologies related to RF technology and its VLSI implementation.	LOTS: Level 1 Remember
CO 2	**Explain** the working and VLSI implementation of various circuits used in RF systems.	LOTS: Level 2 Understand
CO 3	**Apply** the concept of RF technology in the design of the basic blocks used in RF systems.	LOTS: Level 3 Apply
CO 4	**Analyze** the performance of RF circuits.	HOTS: Level 4 Analyze

Course Contents

UNIT-1

Introduction to RF and Wireless Technology: Complexity, design and applications. Choice of Technology.

Basic concepts in RF Design: Nonlinearly and Time Variance, inter-symbol Interference, random processes and Noise. Definitions of sensitivity and dynamic range, conversion Gains and Distortion.

UNIT-2

Analog and Digital Modulation for RF circuits: Comparison of various techniques for power efficiency. Coherent and Non-coherent defection. Mobile RF Communication systems and basics of Multiple Access techniques. Receiver and Transmitter Architectures and Testing heterodyne, Homodyne, Image-reject, Direct-IF and sub-sampled receivers. Direct Conversion and two steps transmitters. BJT and MOSFET behavior at RF frequencies Modeling of the transistors and SPICE models. Noise performance and limitation of devices. Integrated Parasitic elements at high frequencies and their monolithic implementation.

UNIT-3

Basic blocks in RF systems and their VLSI implementation: Low Noise Amplifiers design in various technologies. Design of Mixers at GHz frequency range. Various Mixers, their working and implementations, Oscillators: Basic topologies VCO and definition of phase noise. Noise-Power trade-off, Resonator-less VCO design, Quadrature and single-sideband generators.

UNIT-4

Radio Frequency Synthesizes: PLLS, Various RF synthesizer architectures and frequency dividers, Power Amplifiers design. Linearisation techniques, Design issues in integrated RF filters. Some discussion on available CAD tools for RF VLSI designs.

Reference Books:

1. B. Razavi, "*RF Microelectronics*", Pearson Education, Second Edition, 2012.
2. Thomas Lee, "*The Design of CMOS Radio Frequency Integrated Circuits*", Cambridge University Press, Second Edition, 2004
3. B.Razavi, "*Design of Analog CMOS Integrated Circuits*", First Edition, McGraw Hill, 2001.
4. R.Jacob Baker, "*CMOS Circuit Design Layout and Simulation*", Third Edition, Wiley, 2010.
5. Y.P. Tsividis, "*Mixed Analog-Digital VLSI Devices and Technology*", First Edition, World Scientific, 2002.

Course Articulation Matrix:

RF Micro-Electronics (ECL-731 (ii))					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	H	-	M	H	M
CO2	M	-	H	H	H
CO3	H	L	H	H	H
CO4	H	L	H	H	M

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINNERING

VLSI Testing and Testability
ECL-731 (iii)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: VLSI Design

Course Objectives: This course is introduced to provide the basics of testing techniques for VLSI circuits & to make students understand the various types of faults and fault diagnosis methods. This course also provides the study about the testable memory design and the concepts of the test generation methods.

Course Outcomes:

S.No.	At the end of the semester, students will be able to	RBT Level
CO 1	**Describe** the basic significance of testing which can help them to design a better yield in IC design.	LOTS: Level 1 Remember
CO 2	**Explain** the test generation in sequential and combinational circuits.	LOTS: Level 2 Understand
CO 3	**Demonstrate** the memory test architectures & techniques.	LOTS: Level 3 Apply
CO 4	**Analyze** various trade-offs and techniques for testability.	HOTS: Level 4 Analyze
CO 5	**Design & Develop** more efficient tools from fault coverage and speed point of view.	HOTS: Level 6 Create

Course Contents

UNIT-1

Introduction: The need for testing, the problems of digital and analog testing, Design for test, Software testing Faults in Digital circuits:General introduction, Controllability and Observability. Fault models - Stuck-at faults, Bridging faults, intermittent faults.

UNIT-2

Digital test pattern generation:Test pattern generation for combinational logic circuits, Manual test pattern generation, Automatic test pattern generation - Roth's D-algorithm, Developments following Roth's D-algorithm, Pseudorandom test pattern generation, Test pattern generation for sequential circuits, Exhaustive, non-exhaustive and pseudorandom 70 test pattern Generation. Delay fault testing.

UNIT-3

Signatures and self-test: Input compression Output compression Arithmetic, Reed-Muller and spectral coefficients, Arithmetic and Reed-Muller coefficients,Spectral coefficients, Coefficienttest signatures, Signature analysis and onlineself-test.

UNIT-4

Testability Techniques: Partitioning and ad hoc methods and Scan-path testing, Boundary scan and IEEE standard 1149.1, Offline built in Self-Test (BIST), Hardware description languages and test

Testing of Analog and Digital circuits: Testing techniques for Filters, A/D Converters, RAM, Programmable logic devices and DSP.

Reference Books:

1. Stanley L. Hurst, *"VLSI Testing: digital and mixed analogue digital techniques"*, First Edition, Inspec/IEEE,1999.
2. Mirron Abramovici, Melvin A. Breuer, Arthur D. Friedman, *"Digital Systems Testing & Testable Design"*, First Edition, Jacio, Publishing House, 2001.
3. P.K.Lala, *"Digital circuit Testing & Testability"*, First edition, Academic Press, 2002.
4. M. Bushnellandand V. Agarwal, *"Essentials of electronic testing for digital, memory & mixed-signal VLSI circuits"*, Kluwer Academic Publisher, 2001 .
5. Vishwani D. Agrawal and Michael L. Bushnell, *"Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits"*, Kluwer Academic Publishers, 2000.
6. L. T. Wang, Cheng Wen Wu and Xiaoqing Wen, *"VLSI Test Principles and Architectures – Design for Testability"*. First Edition, Morgan Kaufmann Publishers, 2006.
7. Robert J. Feugate, Jr. Steven, M. Mentyn, *"Introduction to VLSI Testing"*, PHI, Englehood Cliffs, 1998.

Course Articulation Matrix:

VLSI Testing and Testability (ECL-731(iii))					
	PO1	PO2	PO3	PSO1	PSO2
CO1	H	H	M	M	L
CO2	M	L	H	M	L
CO3	L	L	M	L	M
CO4	M	H	H	M	H
CO5	M	H	H	H	H

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Memory System Design
ECL-731 (iv)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Digital Circuit Design

Course Objectives: This course is for Second year post graduation students. This course is designed for memory system organization, memory technologies, and characterization techniques for memory for low power.

Course Outcomes:

S.No.	At the end of the semester, students will be able to	RBT Level
CO 1	**Define** the concepts and related terminology of memories.	LOTS: Level 1 Remember
CO 2	**Know** the significance of various chip design technologies.	LOTS: Level 2 Understand
CO 3	**Solve** the different problems of DRAM circuits, low power and ultra-low power circuits etc.	LOTS: Level 3 Apply
CO 4	**Solve** problems related to different approaches of memory designing.	HOTS: Level 5 Evaluate
CO 5	**Compile** and Integrate the knowledge of memory designing (RAM, DRAM, High Performance, Low Power, Ultra Low Power etc.) to solve the real world problems.	HOTS: Level 6 Create

Course Contents

UNIT-1

Introduction to Memory Chip Design: Internal Organization of Memory Chips, Memory Cell Array, Peripheral Circuit, I/O Interface Categories of Memory Chip, History of Memory-Cell Development, Basic Operation of The 1-T Cell, Basic Operation of a SRAM Cell, Trends in Non-Volatile Memory Design and Technology, Basic Operation of Flash Memory Cells, Advances in Flash-Memory Design and Technology,

Basics of RAM Design and Technology: Devices, NMOS Static Circuits, NMOS Dynamic Circuits, CMOS Circuits, Basic Memory Circuits, Scaling Law.

UNIT-2

DRAM Circuits: High-Density Technology, High-Performance Circuits, Catalog Specifications of the Standard DRAM, Basic Configuration and Operation of the DRAM Chip, Chip Configuration, Address Multiplexing, Fundamental Chip, Multi-divided Data Line and Word Line, Read and Relevant Circuits, Write and Relevant Circuits, Refresh-Relevant Circuits, Redundancy Techniques, On-Chip Testing Circuits, High Signal-to-Noise Ratio DRAM Design and Technology, Trends in High S/N Ratio Design, Data-Line Noise Reduction, Noise Sources.

UNIT-3

On-Chip Voltage Generators: Substrate-Bias Voltage (VBB) Generator, Voltage Up-Converter, Voltage Down-Converter, Half-VDD Generator, Examples of Advanced On-Chip Voltage Generators.

High-Performance Subsystem Memories: Hierarchical Memory Systems, Memory-Subsystem Technologies, High-Performance Standard DRAMs, Embedded Memories.

UNIT-4

Low-Power Memory Circuits: Sources and Reduction of Power Dissipation in a RAM Subsystem and Chip, Low-Power DRAM Circuits, Low-Power SRAM Circuits.

Ultra-Low-Voltage Memory Circuits: Design Issues for Ultra-Low-Voltage RAM Circuits, Reduction of the Subthreshold Current, Stable Memory-Cell Operation, Suppression of, or Compensation for, Design Parameter Variations, Power-Supply Standardization, Ultra-Low-Voltage DRAM Circuits, Ultra-Low-Voltage SRAM Circuits, Ultra-Low-Voltage SOI Circuits.

Reference Books:

1. K.Itoh, *"VLSI Memory Chip Design"*, First Edition, Springer, 2001.
2. Gerardus Blokdyk, *"Memory Management: A Complete Guide"*, First Edition, 5 STAR Cooks 2021.
3. Roger VillelaIntroducing, *"Mechanisms and APIs for Memory Management: Using Windows OS Native Runtime APIs"*, First Edition, Apress, 2019.
4. DalijaPrasnikar and Neven Prasnikar Jr.,*"Delphi Memory Management: For Classic and ARC Compilers"*, First Edition, Create Space Independent Publishing Platform, 2018.
5. David Atienza Alonso, Stylianos Mamagkakis and Christophe Poucet, *"Dynamic Memory Management for Embedded Systems"*, First Edition, Springer, 2014.
6. Francky Catthoor, Sven Wuytack, G.E. de Greef and Florin Banica, *"Custom Memory Management Methodology: Exploration of Memory Organisation for Embedded Multimedia System Design"*, Springer; 1998.

Course Articulation Matrix:

Memory System Design (ECL-731(iv))					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	H	H	M	M	L
CO2	M	L	H	M	L
CO3	L	L	M	L	M
CO4	M	H	H	M	H
CO5	M	H	H	H	H

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Low Power VLSI Design
ECL-731 (v)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Digital System Design, Digital VLSI Design

Course Objectives: This course is meant for the final year post- graduate students. The objective of the course is to provide the students with the understanding of the need for Low power VLSI chips and various sources of power dissipation in the CMOS IC at different abstraction levels.

Course Outcomes:

Sr. No.	At end of the semester,student will be able to	RBT Level
CO 1	**Describe** low power architectures for VLSI design.	LOTS: Level 1 Remember
CO 2	**Explain** the various sources of power dissipation.	LOTS: Level 2 Understand
CO 3	**Apply** the logics power optimization in VLSI design circuits and systems.	LOTS: Level 3 Apply
CO 4	**Analyze** digital system at different abstraction levels for low power design.	HOTS: Level 4 Analyze
CO 5	**Design** digital circuits and systems for low power IC design, test and estimation.	HOTS: Level 6 Create

Course Content

UNIT-1

Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Physics of power dissipation in CMOS devices.

Device & Technology Impact on Low Power :

Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.

UNIT-2

Power estimation Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems. Monte Carlo simulation.

Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.

UNIT-3

Low Power Design Circuit level: Power consumption in circuits. Flip Flops & Latches design, high capacitance nodes, low power digital cells library Logic level:Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.

Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.

UNIT-4

Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network

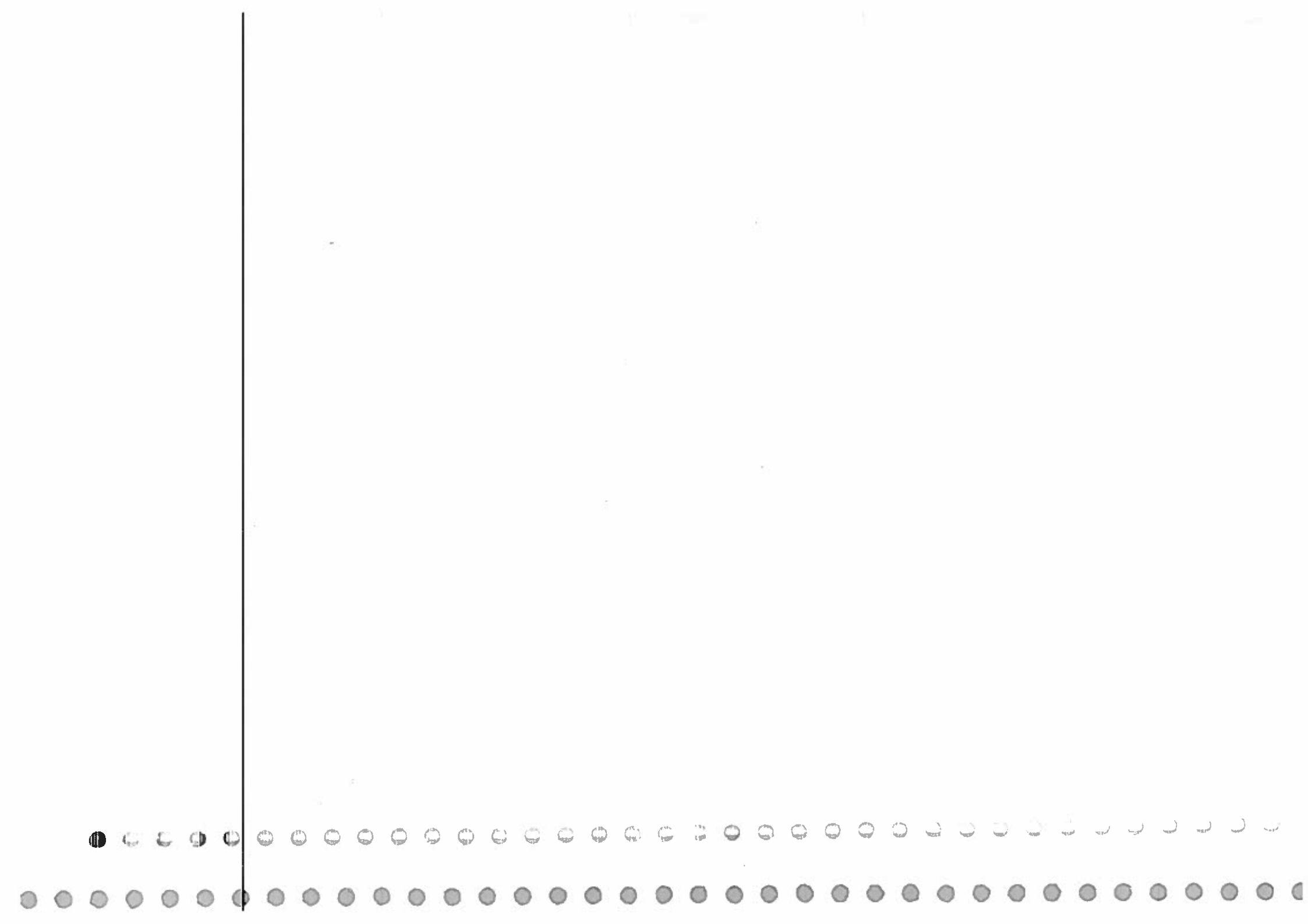
Algorithm & architectural level methodologies: Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.

Reference Books:

1. Gary K. Yeap, *"Practical Low Power Digital VLSI Design"*, Second Edition, KAP, 2002
2. Rabaey, Pedram, *"Low power design methodologies"* First Edition, Kluwer Academic, 1997
3. Kaushik Roy, Sharat Prasad, *"Low-Power CMOS VLSI Circuit Design"*, Second Edition, Wiley, 2000.
4. Dimitrios Soudris, Christians Pignet, Costas Goutis, *"Designing CMOS Circuits for Low Power"*, First Edition, Kluwer, 2002.
5. J.B.Kulo and J.H Lou, *"Low voltage CMOS VLSI Circuits"*, Second Edition, Wiley 1999.
6. Abdelatif Belaouar, Mohamed.I.Elmasry, *"Low power digital VLSI design"*, Second Edition, Kluwer, 1995.

Course Articulation Matrix:

Low Power VLSI Design (ECL-731(v))					
	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	M	H	M	H	H
CO 2	M	H	M	H	M
CO 3	H	H	H	H	M
CO 4	M	H	H	H	M
CO 5	L	M	H	H	M



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Wireless Sensor Networks

ECL-731 (vi)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Wireless Communication and Computer Networks

Course Objectives: This elective course is a blend of the concepts developed in the core courses like wireless mobile communication and computer networks. This course is aimed todevelop the basic understanding and impart in-depth knowledge of various topics like wireless sensor network architecture, protocols & its establishment.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBTLevel
CO 1	**Outline** the terminology, general architecture and application areas of wireless sensor networks.	LOTS: Level 1 Remember
CO 2	**Explain** the working of WSNs with the help of various MAC, routing and transport control protocols.	LOTS: Level 2 Understand
CO 3	**Apply** the knowledge gained to address the design issues and challenges involved in wireless sensor networks.	LOTS: Level 3 Apply
CO 4	**Analyze** the working and performance of various WSN protocols and systems.	HOTS: Level 4 Analyze

Course Content

UNIT-1

Introduction: Architectural Elements, Basic Technology, Sensor Node, Hardware and Software, Sensor Taxonomy, Design challenges, Characteristics and requirements of WSNs, Applications.

UNIT-2

MAC Protocols for WSN: Fundamentals of MAC Protocols, Performance Requirements, Common Protocols, MAC for WSN, Schedule based protocols, Random Access based Protocols, Sensor-MAC, IEEE802.15.4 LR-WPAN's Standard

UNIT-3

Routing Protocols for WSN: Data Dissemination and Gathering, Challenges and Design Issues, Network Scale and TimeVarying Characteristics, Routing Strategies, Flooding and its variants.

UNIT-4

Transport Control Protocols for WSN: Design Issues, Congestion Detection and Avoidance, Event-to-Sink Reliable Transport, Reliable Multi-segment Transport; Pump Slowly, Fetch Quickly, GARUDA, ATP, Congestion and Packet Loss Recovery.
WSN Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, localization and positioning, Sensor Tasking and Control.

Reference Books:

1. K. Sohraby, Minoli, and T. Znati, *"Wireless Sensor Networks: Technology, Protocolsand Applications"*, John Wiley and Sons, 2007.
2. H. Karl and A. Willig, *"Protocols and Architectures for Wireless Sensor Networks"*, John Wiley and Sons, 2007.
3. C.S. Raghavendra, K.M. Sivalingam and T. Zanti, *"Wireless Sensor Networks"*, Springer Verlag, Sep. 2006.
4. W. Dargie, C. Poellabauer, *"Fundamentals of Wireless Sensor Networks: Theory and Practice,"* John Wiley & Sons, 2010.
5. E.H. Callaway Jr., *"Wireless Sensor Networks: Architectures and Protocols "*, Auerbach Publications, CRC Press, 2004.

Course Articulation Matrix:

Wireless Sensor Networks (ECL-731 (vi))					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO1	-	-	L	L	L
CO2	L	-	M	H	L
CO3	L	-	H	H	M
CO4	M	-	H	H	M

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Advanced Digital Communication
ECL-731 (vii)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Communication system

Course Objectives: This subject aims to develop a thorough understanding of the main concepts, techniques and performance criteria used in the analysis and design of digital communication systems.

Topics include:-

1. Introduction of digital communication system.
2. Digital modulation techniques.
3. Reception of digital signal.
4. Information theory and coding.

Course Outcomes:

S.No.	At the end of the semester, students will be able to	RBT Level
CO 1	**Describe** the basic significance of various factors in design of digital communication system.	LOTS: Level 1 Remember
CO 2	**Explain** the transmitter & receiver structure of various digital communication system	LOTS: Level 2 Understand
CO 3	**Demonstrate** the performance of digital communication systems based on various modulation techniques.	LOTS: Level 3 Apply
CO 4	**Analyze** modulation techniques used in a modern digital communication system.	HOTS: Level 4 Analyze
CO 5	**Design** advanced digital communication systems using modulation techniques and coding.	HOTS: Level 6 Create

Course Content

UNIT-1

Introduction: Elements of Digital Communication system, Bandpass and Lowpass signal representation, Comparison between analog &digital communication, Performance parameters of Digital Communication, Concept of Constellation, BER, etc.

UNIT-2

Digital Modulation Techniques: Representation of Digitally Modulated signal, Memoryless modulation method: pulse amplitude modulation, phase modulation, Quadrature Amplitude modulation; Memory based modulation methods: Continuous Phase Frequency-Shift Keying, Continuous Phase Modulation.

UNIT-3

Reception of Digital Signal: Baseband signal reception, Probability of error, Optimum filter receiver, Matched filter receiver, Coherent reception, calculation of error probability for PSK, MSK, ISI.

UNIT-4

Communication Link Analysis: Channel: error-performance degradation, Sources of signal loss and noise; the range equation of received signal power and noise power, received signal power and path loss in terms of frequency, Link Budget analysis, link budget calculation in decibels, link margin, Link availability, Link budget details, system Trade-offs.

Reference Books:

1. J.G Proakis and M Salehi, "*Digital Communications*", Fifth Edition, TataMcGraw Hill, 2008.
2. H. Taub and D. L. Schilling, "*Principle of Communication systems*", Third Edition, TataMcGraw Hill, 2011.
3. S. Haykin, "*Digital Communications*", Fourth Edition, John Wiley & Sons, 2001.
4. B. Sklar and P. K. Ray, "*Digial Communications – Fundamentals and Applications*", Second Edition, Pearson, 2001.
5. B.P.Lathi,"*Modern Digital and Analog Communication Systems*", Fifth Edition, Oxford University Press, 2019.

Course Articulation Matrix:

Advanced Digital Communication (ECL-731 (vii))					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO 1	H	H	M	M	L
CO 2	M	L	H	M	L
CO 3	L	L	M	L	M
CO 4	M	H	H	M	H
CO 5	M	H	H	H	H

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Satellite Communication
ECL-731 (viii)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Communication System

Course Objectives: Satellite Communication Systems play a vital role in the global telecommunication system. It provides an essential and economical fixed and mobile communication services over broad coverage areas of land, sea and air. The course goal for Satellite Communications is to provide the student with the basic understanding and an in-depth knowledge of various concepts used in a satellite communication system. In this course, you will learn the about the science behind the orbiting satellites, link design and calculation, various multiple access schemes and earth station parameters used for satellite communication. In the end various applications of satellite communication will be discussed.

Course Outcomes:

Sr. No.	At end of the semester, students will be able to	RBT Level
CO 1	**Describe** terminologies & various terms of satellite communication systems.	LOTS: Level 1 Remember
CO 2	**Generalize** various applications of satellite communication systems.	LOTS: Level 2 Understand
CO 3	**Demonstrate** the concepts of space segment and earth segment in satellite communication systems.	LOTS: Level 3 Apply
CO 4	**Compare** the performance of various multiple access techniques in satellite communication.	HOTS: Level 4 Analyze
CO 5	**Design** basic link design equation based on the various parameters.	HOTS: Level 6 Create

Course Content

UNIT-1

Basics of Satellite Communication:
Overview of Satellite Systems, Frequency Allocations for Satellite Services, Orbits and Launching Methods, Orbital Elements, Inclined Orbits, The Geostationary Orbit, Antenna Look Angles, Limits of Visibility, Launching Orbits.

UNIT-2

The Space Segment & Earth Segment:
The Power Supply, Attitude & Thermal Control, Station Keeping, TT&C Subsystem, Transponders, Receive-Only Home TV.

The Space Link:
Link-Power Budget Equation, System Noise, Carrier-to-Noise Ratio, Input back-off, Output back-off, Effects of Rain, Combined Uplink and Downlink *C/N* Ratio.

UNIT-3

Access Techniques:
FDMA, Spade System, TDMA, On-Board Signal Processing for FDMA/TDM Operation, Satellite-Switched TDMA, Code-Division Multiple Access.

UNIT-4

Satellite Applications:
Direct Broadcast Satellite (DBS) Television, High Definition Television (HDTV), Satellite Mobile Services, VSATs, Radarsat, Global Positioning Satellite System (GPS), Orbcomm.

Reference Books:

1. D. Rody, *"Satellite Communication"*, Fourth Edition, Prentice Hall, 1983.
2. Tri T.Ha, *"Digital Satellite Communication"*, Second Edition, McGraw Hill, 1990.
3. K. Feher, *"Digital Communication Satellite / Earth Station Engineering"*, Prentice Hall, 1983.
4. Bruce R. Elbert, *"The Satellite Communication Applications Hand Book"*, Artech House, 1997.
5. W. L. Pritchard, H. G. Suyder hood, R. A. Nelson, *"Satellite Communication Systems Engineering"*, Second Edition, Prentice Hall, 1993.

Course Articulation Matrix:

Satellite Communication (ECL-731 (viii))					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	M	H	H	H	M
CO 2	M	L	H	H	H
CO 3	M	L	H	M	H
CO 4	M	M	H	H	H
CO 5	M	M	H	H	H

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

FPGA Design
ECL-731(ix)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Digital System Design, Hardware Description Languages

Course Objectives: The course provides an overview of FPGA VLSI Design, particularly for arithmetic logic and systems and deals with both the function of related components and system performance. The classification and requirements of FPGA for design automation, HDL design, ynthesis for FPGA and ASIC design with practical implementation are demonstrated.

Course Outcomes:

Sr. No.	At end of the semester, student will be able to	RBT Level
CO 1	**Describe** the concept of HDL and digital design flow for electronic circuits and systems and their technical specifications.	LOTS: Level 1 Remember
CO 2	**Understand** various HDL features and capabilities for circuits and systems design.	LOTS: Level 2 Understand
CO 3	**Apply** the concepts of FPGA for design of digital logics in the integrated circuits and systems.	LOTS: Level 3 Apply
CO 4	**Analyze** digital system at different abstraction levels.	HOTS: Level 4 Analyze
CO 5	**Evaluate** digital system at different abstraction levels.	HOTS: Level 5 Evaluate
CO 6	**Design** digital circuits and systems for IC design, test and verification in the arithmetic functions, digital signal processing, etc.	HOTS: Level 6 Create

Course Content

UNIT-1

Digital system design automation with Verilog, digital design flow, ASICs, FPGAs, Architectures of XILINX and ALTERA FPGA devices, hardware modelling with Verilog, System Verilog, RTL Level design with Verilog-architecture based coding in Verilog, design example for architecting speed, power and area in Verilog for FPGA design. High level design, design abstractions, Processor, Memory, Arrays, state machines, DSP Design, clock domains.

UNIT-2

FPGA in arithmetic circuits, implementation of math functions, floating point unit design, microprocessor design, FPGA applications in DSP, image processing, speech processing, audio processing, information system, instrumentation and control system, computer system vision, machine learning, artificial intelligent, Reconfigurable design and architectures.

UNIT-3

Coding for synthesis, Efficient resource utilization, Constrains based synthesis, False paths and multi cycle paths, constraint file creation, Gate level simulation, high-level synthesis, Floor Planning, placement, Back annotation. SDF Format, hardware testing and design for testability,

fault models, fault coverage, ATPG, functional tests, types of DFT, Scan insertion, BIST, verification and verification methodologies.

UNIT-4

Industry Standard FPGA and ASIC design tools, FPGA Design flows, IP generator, System generator, memory controller, Scripting and customization of tool environment, simulation, synthesis, clocking, timing and power analysis, timing closure, hardware debug.

Reference Books:

1. Z. Navabi, *"Verilog Digital System Design"*, Second Edition, McGraw Hill, 2015.
2. Steve Kilts, *"Advanced FPGA Design-Architecture, Implementation, and Optimization"*, Second Edition, Wiley, 2007.
3. Hong Jeong, *"Architectures for Computer Vision from Algorithm to Chip with Verilog"*, First Edition, Wiley, 2014.
4. Sanjay Churiwala, *"Designing with Xilinx FPGAs-Vivado"*, First Edition, Springer, 2017.
5. Uwe Meyer-Baese, *"Signal and Communication Technology-Digital Signal Processing with Field Programmable Gate Arrays"*, Fourth Edition, Springer, 2014.
6. M. Morris Mano, Michael D. Ciletti, *"Digital Design with an Introduction to the Verilog HDL, VHDL, and SystemVerilog"*, Sixth Edition, Pearson Education, 2018.

Course Articulation Matrix:

FPGA Design (ECL-731(ix))					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	H	H	H	H	H
CO 2	H	H	H	H	M
CO 3	H	H	H	H	M
CO 4	M	H	H	H	M
CO 5	H	H	H	H	M
CO 6	H	H	H	H	M

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Advanced Antenna Theory and Design
ECL-731(x)

General Course Information

Course Credits: 3 Type: Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Electromagnetic theory, antenna and wave propagation

Course Objective: This course is for second year post graduation students. The course objective is to understand the theory and fundamentals of antenna design. The course helps the students to learn key aspects of practical antenna design. A broad range of antennas such as dipole, loop, microstrip patch, horn, etc are studied during the course.

Course Outcome:

Sr. No.	At the end of the semester, students will be able to:	RBT Level
CO 1	**Memorize and define** standard antenna characterization parameters such as: impedance, far-field radiation pattern, scattering pattern, gain, directivity, bandwidth, beam width, polarization, and efficiency.	LOTS: Level1 Remember
CO 2	**Explain** the basics and theory behind antenna radiation mechanisms, point sources, small-wave dipoles, half-wave dipoles, and the fundamentals of antenna measurements.	LOTS: Level 2 Understand
CO 3	**Apply** the fundamental knowledge gained about electromagnetic radiation mechanism and its physics and be able to **examine** radiation from several common antenna structures.	LOTS: Level 3 Apply
CO 4	**Analyze** the requirements and potential design options for different antenna applications.	HOTS: Level 4 Analyze
CO 5	**Evaluate** the performance characteristics of antennas using different performance parameters.	HOTS: Level 5 Evaluate
CO 6	**Design** antennas such as dipoles, microstrip patches, horns and antenna arrays to achieve specified performance.	HOTS: Level 6 Create

Course Content

UNIT -1

Antenna Fundamentals: Fundamentals of electromagnetics, the ideal dipole, radiation patterns, directivity and gain, antenna impedance, radiation efficiency, antenna polarization.
Simple radiating elements: half wave dipoles, monopoles, loop antennas, two element arrays.
System applications for antennas: Receiving properties of antennas, antenna noise and radiometry, antennas in wireless communication systems, antennas in radar systems.

UNIT-2

Broadband Antennas: Travelling wave wire antennas, helical antennas, biconical antennas, sleeve antennas, spiral antennas, wideband EMC antennas, Ultra-wideband antennas.
Aperture Antennas: Radiation from apertures and Huygens' principle, rectangular apertures, rectangular horn antennas, circular apertures, reflector antennas, feed antennas for reflectors, Lens antenna.
Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.

UNIT-3

Low-Profile Antennas and Personal Communication Antennas: Introduction, Microstrip antenna elements: Rectangular microstrip patch antennas, other microstrip patch antennas and their applications, broadband microstrip patch antennas, microstrip arrays, microstrip leaky

wave antennas: characteristics of leaky wave antennas, microstrip modes, propagation regimes.

Antennas for Compact Devices: Normal mode helix type antennas, planar Inverted-F Type antennas, other compact antennas, multiband/broadband handset antennas, radio frequency identification (RFID) antennas, Dielectric resonator antennas.

UNIT-4

Antenna Measurements: Reciprocity and antenna measurements, Antenna Ranges, Radiation Patterns, Gain Measurements, Directivity Measurements, Radiation Efficiency, Impedance Measurements, Current Measurements, Polarization Measurements, Human body effect on antenna performance, radiation hazards.

Reference Books:

1. C. A. Balanis, *"Antenna Theory Analysis and Design"*, Fourth Edition, John Wiley & Sons, 2016.
2. W. L. Stutzman and G. A. Thiele, *"Antenna Theory and Design"*, Third Edition, John Wiley & Sons, 2013.
3. J. D. Kraus and R. J. Marhefka, *"Antennas for All Applications"*, First Edition, TataMcGraw-Hill, 2003.
4. J. L. Volakis, *"Antenna Engineering handbook"*, Fifth Edition, TataMcGraw-Hill, 2019.
5. R. Garg, P. Bhartia, I. J. Bahl, A. Ittipiboon, *"Microstrip Antenna Design Handbook"* First Edition, Artech house, 2001.

Course Articulation Matrix:

Advanced Antenna Theory and Design (ECL-731(x))					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	M	-	L	M	L
CO 2	M	M	M	H	M
CO 3	M	M	M	H	H
CO 4	H	M	H	H	H
CO 5	H	M	H	H	H
CO 6	H	M	M	H	H

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Course no.	Title of course	Core/Open	Credit	L
3OE01	Business Analytics	Open	3	3

Course objective

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.	9
Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	8
Unit 3: Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis. Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	9
Unit 4: Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.	10

LECTURE WITH BREAKUP	NO. OF LECTURES
Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model. Overbooking Model, Cash Budget Model.	
Unit 5: Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees. The Value of Information, Utility and Decision Making.	8
Unit 6: Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	4

COURSE OUTCOMES

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Course no.	Title of course	Core/Open	Credit	L
3OE02	Industrial Safety	Open	3	3

Unit-I: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit-II: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, 1. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical Model motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: 1. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Course no.	Title of course	Core/Open	Credit	L
3OE03	Operations Research	Open	3	3

Course Outcomes: At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

Syllabus Contents:

Unit 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Unit 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory – dual simplex method - sensitivity analysis - parametric programming

Unit 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem – max flow problem - CPM/PERT

Unit 4

Scheduling and sequencing - single server and multiple server models – deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Unit 5

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Course no.	Title of course	Core/Open	Credit	L
3OE04	Cost Management of Engineering Projects	Open	3	3

Introduction and Overview of the Strategic Cost Management Process
Cost concepts in decision-making, Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning. Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Course no.	Title of course	Core/Open	Credit	L
3OE05	Composite Materials	Open	3	3

UNIT–I: INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – II: REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT – III: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–IV: Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – V: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Course no.	Title of course	Core/Open	Credit	L
3OE06	Waste to Energy	Open	3	3

Unit-I: Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit-II: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit-III: Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit-IV: Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit-V: Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Advanced Communication Systems
3OE07

General Course information

Course Credits: 3 Type: Open Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks

Pre-requisites: Analog & Digital Communication System

Course Objectives:
This course is introduced to build up basic understanding and impart knowledge of various concepts & latest technologies used in wireless communication systems. The course provides holistic understanding about the architecture and elements of different standard communication systems such as optical communication, cellular communication, satellite communication etc.

Course Outcomes:

Sr. No.	At end of the semester, students will be able to	RBT Level
CO 1	**Describe** terminologies & various form of communication systems and there technical specifications.	LOTS: Level 1 Remember
CO 2	**Understand** the concepts of cellular system, optical communication & satellite communication systems.	LOTS: Level 2 Understand
CO 3	**Apply** the concepts of radio planning for cellular mobile communication systems& satellite communication systems.	LOTS: Level 3 Apply
CO 4	**Analyze** the performance of various wireless communication systems.	HOTS: Level 4 Analyze
CO 5	**Design** basic wireless communication system to address the needs of subscriber's requirements with thorough knowledge of latest wireless communication technologies.	HOTS: Level 6 Create

Course Content

UNIT-1

The essentials of a Communication system, Basics of analog modulation like Amplitude modulation, Phase modulation (PM) & frequency modulation (FM), Introduction to ASK, FSK, PSK, Frequency Reuse concept, Introduction to GSM, CDMA, Basic Architecture of GSM, CDMA, Frequency bands & advantages of 3G, 4G & 5G standards, Introduction to LTE standard, VoLTE.

UNIT-2

Introduction to optical communication system: Electromagnetic spectrum used for optical communication, block diagram of optical communication system, Basic principles of light propagation, Total internal reflection, WDM optical networks, Introduction to mm wave communication, Introduction to FSO network.

UNIT-3

Communication signal multiplexing, Time division multiplexing, Frequency division multiplexing, Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access.

Block Diagram, operation & application of RADAR, SONAR.

UNIT-4

Basic block diagram of satellite communication. Basics and operation of various kinds of satellite such as: VSAT(data broadband satellite), MSAT (Mobile Satellite Communication technique), Sarsat (Search & Rescue satellite), Working of GPS.

Reference Books:

1. Kamilo Feher, "*Wireless and Digital Communications*" First Edition, Prentice Hall, 1995.
2. T.S. Rappaport, "*Wireless Communication: Principles and Practice*", Second Edition, Pearson, 2014.
3. D.C. Aggarwal, Rishabh Anand, "*Satellite Communications*", First Edition, Khanna Publishers, 2021.
4. John M. Senior, "*Optical Fiber Communications: Principles and Practice*", Third Edition, Pearson, 2014.
5. M. Skolnik, "*Introduction to RADAR Systems*", Third Edition, McGraw Hill, 2017.

Course Articulation Matrix:

Advanced Communication Systems (3OE07)					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	M	--	H	H	M
CO 2	M	--	H	H	H
CO 3	H	L	H	M	H
CO 4	H	--	H	H	H
CO 5	H	M	H	H	H

3OE08: Introduction to Soft Computing Techniques (3rd Semester)

Course Code: 3OE08 L+T+P: 3+0+0 Credit : 3 (Open Elective) Contact Hours: 3 hours/week	**Course Assessment Methods:** **Internal 30 :** Two minor examinations each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks). **External 70 :** End semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus and will contain seven short answers type questions. Further 8 more questions are to be given from entire syllabus and candidate is required to attempt any four questions. All questions carry equal marks.

Course Objectives:

1. Introduce the soft computing techniques to students of different Engineering Departments.
2. Develop the ability to apply the soft computing techniques like genetic algorithms, fuzzy logic and neural networks in diverse Engineering domains.

By the end of the course a student is expected to:

I. be able to apply Genetic Algorithms, Neural Networks, Fuzzy Logic or a combination of these as computational tools to solve a variety of problems related to optimization in different domains.

II. acquire knowledge of the tools like MATLAB and R to implement soft computing techniques

Units	Contents
1.	Working of a simple Genetic Algorithm and the related definitions: Block diagram of working of a Genetic Algorithm, Representation/Encoding Schemes, initialising a GA population, evaluation function, genetic operators, study of parameters of genetic algorithms and its performance, sampling and selection mechanisms, Optimizing numerical functions using GA.
2.	Genetic Algorithm variations: Scaling fitness, Multi-Objective Genetic Algorithms, Master Slave and Distributed Genetic Algorithms, Designing GAs for numerical optimization, knapsack problem, travelling salesperson and other similar problems.
3.	Neural networks: Basic terminology and definitions, Model of an artificial neuron, Sigmoid function, Neural Network Architectures, Characteristics of neural networks, Learning methods, Rosenblatt's Perceptron, Fixed increment perceptron learning algorithm for a classification problem, Examples of learning of AND/OR gate by perceptron, XOR problem. Back Propagation Neural Networks: Architecture of a back propagation network, Model for multi-layer perceptron, Back propagation learning, Delta or gradient descent learning rule and effect of learning rate, Back propagation learning algorithm
4.	Fuzzy sets: Basic terminology and definitions, Operations on Fuzzy sets, MF formulations and parameterisation, Derivatives of parameterised MFs, Fuzzy numbers, Extension principal and fuzzy relations, Linguistic variables, Fuzzy If-Then Rules, Fuzzy reasoning and compositional rule of inference.

Software and Tools to be learnt: MATLAB tool boxes on global optimization, neural networks and fuzzy logic, R Programming, GALIB 247 and KEEL

Text and Reference Books:

1. David.E. Goldberg, Genetic Algorithms in Search, Optimization and machine learning, Addison Wesley, 1999.
2. Zbigniew Michalewicz, Genetic algorithms +Data Structures = Evolution Programs, Springers-Verlag, 1999.
3. M. Mitchell, An Introduction to Genetic Algorithms, Prentice-Hall, 1998.
4. S. Rajasekaran & G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, PHI, 2003.
5. S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing, Wiley - India, 2007.
6. J-S. R. Jang, C.-T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing, PHI, 1997.
7. Simon O. Haykin, Neural Networks, A Comprehensive Foundation, PHI, 1994.

3OE09: Advanced Printing Technology (3rd Semester)

Course Code: 3OE09 L+T+P: 3+0+0 Credit : 3 (Open Elective) Contact Hours: 3 hours/week	**Course Assessment Methods:** **Internal 30 :** Two minor examinations each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks). **External 70 : End semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus and will contain seven short answers type questions.** Further 8 more questions are to be given from entire syllabus and candidate is required to attempt any four questions. All questions carry equal marks.

Course Objectives:

The objective of this course is to impart the basis knowledge of different printing processes along with their role, importance and applications

Units	Contents
1.	Historical development in Printing Technology. Recent trends in the field of printing and allied technologies. Pre-Press, Press and Post press operations
2.	Letterpress Printing Process; Characteristics, role, importance and applications Offset Printing Process; Characteristics, role, importance and applications
3.	Flexography Printing Process; Characteristics, role, importance and applications. Gravure Printing Process; Characteristics, role, importance and applications
4.	Screen Printing Process; Characteristics, role, importance and applications Digital Printing Process; Characteristics, role, importance and applications

Course Outcome

The learning outcome of this course is expected that after completion of this course the students will be having the detail knowledge of various printing processes and the recent development in this industry and they will implement their knowledge for print production operations

References:

1. Sheet-Fed Offset Technology, By Sh. Anjan Kumar Baral
2. Letterpress Printing, By C.S. Mishra
3. On demand printing, By Havoed M Fenton, Frank J. Romao
4. Printing Technology, By Adams Fox

3OE10: Computer Aided Design & Manufacturing
(3rd Semester)

Course Code: 3OE10 L+T+P: 3+0+0 Credit : 3 (Open Elective) Contact Hours: 3 hours/week	**Course Assessment Methods:** **Internal 30 :** Two minor examinations each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks). **External 70 :** End semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus and will contain seven short answers type questions. Further 8 more questions are to be given from entire syllabus and candidate is required to attempt any four questions. All questions carry equal marks.

Course Objectives:

- To understand the basic parametric fundamentals that is used to create and manipulate geometric models.
- To learn about the concepts of surface modeling and solid modeling.
- To implement CNC programs for milling and Turning machining operations,
- To create a computer aided manufacturing (CAM) model and generate the machining codes automatically using the CAM system

Units	Contents
1.	Introduction: Introduction to CAD/CAM, Historical developments, Industrial look at CAD/CAM, Introduction to CIM; Basics of geometric and solid modeling, explicit, implicit, intrinsic and parametric equations, coordinate systems Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects
2.	Curves: Algebraic and geometric forms, tangents and normal, blending functions reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves. Surfaces: Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, sixteen point form, four curve form, plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-spline surface. Solids: Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration.
3.	Automation and Numerical Control: Introduction, fixed, programmable and flexible automation, types of NC systems, MCU and other components, NC manual part programming, coordinate systems, G & M codes, Part program for simple parts, computer assisted part programming
4.	Group Technology: Part families, part classification and coding, production flow analysis, Machine cell design, Advantages of GT Flexible Manufacturing Systems & Computer aided process planning: Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, advantages and applications Coventional process planning, types of CAPP, Steps in variant process

	planning, planning for CAPP.

Course Outcomes:

Students would learn about the concepts of surface modeling, physically based modeling and surface visualization.

Students would be able Implement CNC programs for milling and turning machining operations

Books:

1. CAD/ CAM by Groover and Zimmer, Prantice Hall.
2. CAD/ CAM Theory and Practice by Zeid, McGraw Hill
3. CAD/CAM (Principles, Practice & Manufacturing Management) by Chirs Mc Mohan & Jimmie Browne, Published by Addison- Wesley.
4. Numerical Control and Computer Aided Manufacturing by Kundra, Rao & Tiwari, TMH.
5. Automation, Production Systems and Computer Integrated Manufacturing, Groover M.P, Prentice Hall of India.

3OE11: Food Safety and Quality Assurance
(3rd Semester)

Course Code: 3OE11 L+T+P: 3+0+0 Credit : 3 (Open Elective) Contact Hours: 3 hours/week	**Course Assessment Methods:** **Internal 30 :** Two minor examinations each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks). **External 70 :** End semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syliabus and will contain seven short answers type questions. Further 8 more questions are to be given from entire syllabus and candidate is required to attempt any four questions. All questions carry equal marks.

Course Objectives:

- To illustrate the importance of food safety, food quality, food laws and regulations in Food industry.
- To describe the food quality management systems.
- To explain the nationals and international food laws and regulations.
- To exemplify different food adulterants.

Units	Contents
1.	Sampling, specification, labeling, safety and quality assessment of fruits and vegetable, cereals, dairy products, meat, fish, poultry and processed food products, Sensory evaluation: Introduction, panel screening, selection methods, interaction and thresholds
2.	Developments, objective and functions of food safety and quality assurance, Quality enhancement models, Statistical Quality Control for food industry, Food Quality Management Systems, implementation of quality control programmes, Quality control tools, Quality control charts for food plant sanitation, Food Safety Management Systems, Causes of failure of Food Safety Programs
3.	Indian food laws and regulations, Food safety acts, Regulations for waste disposals, Codex alimentarious, ISO series, World Trade Organization, Food and Agricultural Organization, World Health Organization, Food safety and legislation in USA and Europe, Technical Barriers in Trade, Enforcers of food laws approval process for food additives, additives food labeling, Intellectual Property Right, HACCP and its application.
4.	Food adulteration: Types of adulterants, Common adulterants for foods like milk and milk products, honey, wheat flours, edible oils, cereals, condiments (whole and ground) pulses, coffee, tea, confectionery, baking powder, non-alcoholic beverages, vinegar, besan and curry powder

Course Outcomes:

After the completion of the course, the students will be able to:

1. Understand various areas of Food Safety & Quality Assurance.
2. Grasp knowledge of the quality assessments of food products.
3. Comprehend food quality managements systems.
4. Apprehend the Indian and International food laws.
5. Conceive the concept of adulteration in food products.

Recommended Readings:

- Lawless, H. T. and Heymann, H. (2013). ***Sensory Evaluation of Food: Principles and Practices***: Springer, New Delhi.
- Shapton, D. A. and Shapton, N. F. (1993). *Principles and Practice for the Safe Processing of Foods*: Heinemann, Oxford.
- Schmidt, R. H. and Rodrick, G. E. (2003). *Food Safety Handbook*. John Wiley, New Jersey.
- Rees, N. and Watson, D. (2000). *International Standards for Food Safety*: Aspen, America.
- Anjaneyulu, Y. and Marayya, R. (2009). *Quality Assurance and Quality Management in Pharmaceutical Industry*: Pharma, Hyderbad.
- Ho, S. K. M. (1999). *Operations and Quality Management*: ITP, London.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Advance VLSI Design Lab
ECP-732

Course code	Title of course	Core/Elective	Credit	L	P
ECP-732	Advance VLSI Design Lab	Core	2	0	4
Max. Marks: 100		External: 70 Marks, Internal: 30 Marks			

Pre-requisites: Analog Electronics, Digital VLSI Design

Course Objective:

This course is for first year post graduation students. This course is designed to give students in hand practice of writing and simulating a Verilog code which is one of the popular hardware descriptive language. Various combinational and sequential circuits like simple logic gates, Half Adder, Full Adder, Multiplexer, Demultiplexer, Encoder, decoder, Flip-Flops, Shift Register, Counters are included.

Course Outcomes:

Sr. No.	At end of the semester, student will be able to	RBT Level
CO-1	**Understand** CAD tools and technologies for VLSI logic, gates, circuits and systems for Analog, Digital and AMS	LOTS: Levels 3 Apply
CO-2	**Analyze and compare** the outcomes of different experimental models of Analog, Digital and AMS systems.	HOTS: Level 4 Analyse
CO-3	**Evaluate** the performance of logics design and verification of Analog, Digital and AMS systems.	HOTS: Level 5 Evaluate
CO-4	**Integrate** knowledge for design ofdigital circuits and systems for VLSI design, test and verification.	HOTS: Level 6 Create
CO-5	**Create** written records for the given experiments with problem definition, solution, observations & conclusion.	HOTS: Level 6 Create
CO-6	**Demonstrate** ethical practices while performing lab experiments individually or in the group.	LOTS: Level 3 Apply

List of Experiments

1. Design and simulate the CMOS Inverting amplifiers stages.
2. Design and simulate the layout of CMOS inverter.

3. Design of various current-mirror circuits.
4. Design a differential pair circuit.
5. Design an operational transconductance amplifier.
6. Design a three-stage operational amplifier.
7. Design Analog to Digital Converter circuit(s)
8. Design Digital to Analog Converter circuit(s)
9. Design Voltage control oscillator (VCO)

Note: At least eight experiments are to be performed in the semester, out of which atleast six experiments should be performed from the given list. The remaining two experiments may either be performed from the list or designed & setup by the concerned institution as per the scope of the syllabus.

Course Articulation Matrix:

Advance VLSI Design Lab (ECP-732)					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	H	M	H	H	H
CO 2	H	M	H	H	H
CO 3	H	M	H	H	H
CO 4	H	M	M	H	M
CO 5	L	H	L	L	L
CO 6	H	M	--	--	--

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Communication System Design Lab
ECP-733

Course code	Title of course	Core/Elective	Credit	L	P
ECP-733	Communication System Design Lab	Core	2	0	4
Max. Marks: 100		External: 70 Marks, Internal: 30 Marks			

Pre-requisites: Communication System

Course Objectives:

The course provides an overview of optical communication, particularly fiber optics and deals with both the function of related components and system performance. Various fiber impairments including linear & non-linear effects are investigated in terms of different metrices like BER, Q factor, eye diagram etc.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able:	RBT Level
CO 1	**Identify** software tools and apply these tools to simulate different optical links.	LOTS: Levels 1 Remember
CO 2	**Analyze** the outcomes of designed optical networks.	HOTS: Level 4 Analyse
CO 3	**Evaluate** the performance of developed optical links against different limitations of optical fiber transmission.	HOTS: Level 5 Evaluate
CO 4	**Combine** knowledge for design of different types of optical links using various optical components for long haul quality transmission.	HOTS: Level 6 Create
CO 5	**Create** written records for the given experiments with problem definition, solution, observations & conclusion.	HOTS: Level 6 Create
CO 6	**Demonstrate** ethical practices while performing lab experiments individually or in the group.	LOTS: Level 3 Apply

List of Experiments

1. To study dispersion in optical links, with and without compensation.

2. To study four channels WDM using computer system using two spans of dispersion shifted fiber of opposite dispersion value.
3. To study fiber linear effects (Polarization mode dispersion).
4. To study self-phase modulation by establishing an optical link.
5. To study cross phase modulation (XPM)by establishing an optical link.
6. To study Stimulated Raman Scattering (SRS) effect by establishing a WDMoptical link.
7. To study Four Wave Mixing (FWM) by establishing aWDMoptical link.
8. To design an optical link of 100 km length and to evaluate BER & Q factor.
9. To design DQPSK modulated optical communication link using RZ. NRZ & duo binary technique.
10. To design an optical fiber transmission link in the presence of combined non linear effects.

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement.

Course Articulation Matrix:

Communication System Design Lab (ECP-733)					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	H	L	M	H	H
CO 2	H	L	H	H	M
CO 3	H	M	H	H	H
CO 4	H	M	H	H	H
CO 5	L	H	L	L	L
CO 6	H	M	--	--	--

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Dissertation-Part I
ECD-730

Course Code	Title of course	Core/Elective	Credit	L	P
ECD-730	Dissertation-Part I	Core	3	0	*
Max Marks: 100 (Evaluation will be done internally by the dept. including the supervisor concerned)					

Course Assessment Methods: Both Continuous & Semester End Assessment

Pre-requisites: Knowledge of research area

Course Objective: The objective of this course is to make students capable of carrying out detailed literature review in the respective research area. The students should be able to identify research issues, gaps in the literature and thus formulate the specific research problem.

Course Outcomes:

Sr. No.	At the end of the semester students will be able to:	RBTLevel
CO 1	**Summarize** the findings of research papers related to a topic and identify the gaps through extensive literature survey.	LOTS: Level 2 Understand
CO 2	**Use** different modern hardware and software tools to carry out research in the domain of ECE.	LOTS: Level 3 Apply
CO 3	**Analyze** the existing researchcritically to formulate the research problem.	HOTS: Level 4 Analyze
CO 4	**Compile** research ideas in theform of asynopsis/report and present them in an effective manner.	HOTS: Level 6 Create

The dissertation work should be of Research nature only and it should be started during the thirdsemester and the candidate must do the following:

a) Literature Survey
b) Problem Formulation

Around 40% of the dissertation work should be completed in this semester. The remaining 60% work will be carried out in the fourth semester. Each student is required to submit a detailed report about the work done on topic of dissertation as per the guidelines decided by

the department. The dissertation work is to be evaluated internally through Presentations during the semester and Viva-Voce at the end of semester as per the guidelines decided by the department from time to time.

***2 hrs per student per week teaching load will be assigned to supervisor.**
Mode: One-to-one discussions with the Supervisor.

Course Articulation Matrix:

Dissertation–Part I (ECD-730)					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	H	L	H	H	-
CO 2	H	-	H	H	H
CO 3	H	-	H	H	H
CO 4	M	H	-	-	-

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Seminar
ECP-735

Course code	Title of course	Core/Elective	Credit	L	P
ECP-735	Seminar	Core	1	0	2
Max. Marks: 100		Internal: 100 Marks			

Course Assessment Methods: Both Continuous & Semester End Assessment

Course Objectives: This course is introduced for the students to learn fundamental principles, concepts or theories and to identify & compare technical and practical issues related to the area of specialization.It also motivates the students to prepare a well-organized report employing elements of technical writing and critical thinking for promotion and development of presentation skills.

Course Outcomes:

S.No.	At the end of the semester, students will be able to	RBT Level
CO 1	**Describe** any topic of interest and develop a thought process for technical presentation.	LOTS: Level 1 Remember
CO 2	**Explain** technical issues and give oral presentations related to the work completed.	LOTS: Level 2 Understand
CO 3	**Demonstrate** ability to use technical resources available.	LOTS: Level 3 Apply
CO 4	**Compare** technical issues and develop competence in presenting.	HOTS: Level 5 Evaluate
CO 5	**Develop** their communication skills.	HOTS: Level 6 Create

Course Articulation Matrix:

Seminar (ECP-735)					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	H	M	M	M	L
CO2	H	H	M	L	M
CO3	H	L	L	M	H
CO4	H	H	M	M	M
CO5	H	M	M	L	L

Fourth Semester

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Dissertation–Part II
ECD-740

Course Code	Title of course	Core/Elective	Credit	L	P
ECD-740	Dissertation–Part II	Core	8	0	*
Max Marks: 100 (The evaluation will be done by external exam conducted jointly by the external examiner and the supervisor concerned as internal examiner.)					

Course Assessment Methods: Both Continuous & Semester End Assessment

Pre-requisites: Knowledge of research area

Course Objective: The main objective of this course is to make students capable of carrying out research / investigation and development work independently to solve practical problems. Further, it is also aimed to develop solution oriented understanding and higher degree of mastery in the specialized area of electronics and communication engineering.

Course Outcomes:

Sr. No.	At the end of the semester students will be able to:	RBTLevel
CO1	**Apply** advanced concepts, research methodology and knowledge of simulation tools to solve the research problem.	LOTS: Level 3 Apply
CO2	**Analyze** research objectives critically and explore a logical solution through experimentation / simulation for the proposed research work.	HOTS: Level 4 Analyze
CO3	**Evaluate** the experimentation / simulation results of the proposed research.	HOTS: Level 5 Evaluate
CO4	**Devise** a novel & effective solution to the research problem and write dissertation/papers in a professional and ethical manner.	HOTS: Level 6 Create

Around 40% of the dissertation work should be completed in third semester. The remaining 60%work will be carried out in this semester. Each student is required to submit a detailed Dissertation report of the work done (III Sem + IV Sem) on topic of Dissertation as per the uidelines decided by the department.

The Dissertation work is to be evaluated continuously through presentations during the semester. The candidate will be required to present his/her research work before submitting his/her Dissertation (pre-submission) in front of dept. committee including Chairperson of the

department. Final dissertation evaluation/ viva voce will be done at the end of semester as per the guidelines decided by the department/university from time to time.

The candidate has to present/publish one paper in national/international conference/ symposium/journalbefore the submission of Dissertation. Research work should be carried out at GJUS&T Hisar. However. candidate may visit research labs/institutions with the due permission of Chairperson on recommendation of supervisor concerned.

***02 hrs per student per week teaching load will be assigned to supervisor.**
Mode: One-to-one discussions with the Supervisor.

Course Articulation Matrix:

Dissertation–Part II (ECD-740)					
	PO 1	**PO 2**	**PO 3**	**PSO 1**	**PSO 2**
CO 1	H	-	H	H	H
CO 2	H	-	H	H	H
CO 3	H	M	H	H	H
CO 4	H	H	H	H	H