Semester - II

ANTENNA THEORY AND DESIGN			
Course Code	**MLCS201**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(3:2:0)	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives: Thiscoursewillenablestudents:

- To classify different types of antennas
- To define and illustrate various types of array antennas
- To design antennas like Yagi-Uda, Helical antennas and other broad band antennas
- To describe different antenna synthesis methods
- To apply methods like Method of Moments, Pocklington's integral equation, Source modeling.

MODULE-1

Antenna Fundamentals and Definitions: Radiation Mechanisms, Overview, EM Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation patterns, Directivity and Gain, Antenna impedance, Radiation efficiency, Antenna polarization. **RBT Level: L1, L2**

MODULE-2

Arrays: Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Non-uniformly excited equally spaced linear arrays, Mutual coupling. Antenna Synthesis: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method, Comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods, Dolph Chebyshev linear array, Taylor line source method. **RBT Level: L1, L2**

MODULE-3

Resonant Antennas: Wires and Patches, Dipole antenna, Yagi-Uda antennas, Micro-strip antenna.
Broadband antennas: Traveling wave antennas Helical antennas, Biconical antennas, Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.
RBT Level: L1, L2, L3, L4

MODULE-4

Aperture antennas: Techniques for evaluating gain, Reflector antennas, Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice. **RBT Level: L1, L2**

MODULE 5

Antenna in systems & Measurements: Receiving properties of antennas, Antenna temperature & radiometry.
CEM for antennas: The method of moments: Introduction of the methods moments, Pocklington's integral equation, Integral equation and Kirchhoff's networking equations, Source modeling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics. .
RBT Level: L1, L2, L3

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	MATLAB/C implementation to obtain the radiation pattern of an antenna.
2	Study of radiation pattern of different antennas.
3	Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.
4	Impedance measurements of Horn/Yagi/dipole/Parabolic antennas
5	Study of radiation pattern of E& H plane horns.
6	Significance of Pocklington's integral equation.
7	Determine the directivity and gains of dipole antennas.
8	Impedance measurements of Yagi antennas.
9	Determine the directivity and gains of Parabolic antennas.
10	Study of radiation pattern of E plane horns
11	**Can be Demo experiments for CIE**
12	**Can be Demo experiments for CIE**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **25 Marks**
2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for **10 marks**. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test at the end /after completion of all the experimentsshall be conducted for **50 marks** and scaled down to **05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by the University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources:

Textbook:

'Antenna Theory and Design', Stutzman and Thiele, John Wiley, 2nd Edition, 2010

Reference Books:

1. 'Antenna Theory Analysis and Design', C. A. Balanis, John Wiley, 2nd Edition, 2007
2. 'Antennas and Wave Propagation', J. D. Krauss, McGraw Hill TMH, 4th Edition, 2010
3. 'Antennas and propagation', A.R.Harish, M.Sachidanada, Pearson Education, 2015

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=fIbdW0NGIU0
- https://nptel.ac.in/courses/117107035

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Different types of antenna synthesis or technical seminar on advanced types of antennas.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To classify different types of antennas	Understand
CO2	To define and illustrate various types of array antennas	Understand
CO3	To design antennas like Yagi-Uda, Helical antennas and other broad band antennas	Understand
CO4	To describe different antenna synthesis methods	Understand
CO5	To apply methods like Method of Moments, Pocklington's integral equation, Source modelling	Analyze

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication and Networking domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	1	1	1	2	1	1
CO3	2	1	1	1	1	1
CO4	1	1	1	2	1	1
CO5	1	1	2	1	1	1

ADVANCED COMMUNICATION SYSTEMS -2			
Course Code	**MLCS202**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 HoursTheory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students:

- To describe models for fading channels, and concepts of diversity in time, frequency and space.
- To understand concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver.
- To understand performance in a multipath fading environment including maximal ratio combining, RAKE receivers, OFDM and MIMO.
- Develop and evaluate the performance of a OFDM MIMO scheme to meet specified rate in a given multipath environment.

Module-1

Synchronization – Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery, Performance of ML estimators.

Fading– Large scale, small scale; Statistical characterization of multipath channels – Delay and Doppler spread, classification of multipath channels, scattering function; Binary signaling over frequency non selective Rayleigh fading channel.**RBT Level: L1, L2**

Module-2

Fading Contd.: - Diversity techniques for performance improvement with binary signaling over FNS, Slow fading channels – power combining and Maximal ratio combining; Frequency selective channels – Rake receivers, Performance, Tap weight Synchronization, Application to CDMA.

Multicarrier Signaling: A brief overview of Frequency Diversity. Multicarrier Communications in

Module-3

Capacity of wireless channel: AWGN channel capacity, Resources of AWGN channel, Linear time invariant Gaussian channel, Capacity of Fading Channels.

RBT Level: L2, L3

Module-4

MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels, Physical modeling of MIMO channels, Modeling of MIMO fading channels.

RBT Level: L2, L3

Module-5

MIMO capacity and multiplexing architectures: The VBLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Receiver architectures –(Linear decorrelator, Successive cancellation, Linear MMSE receiver),

Information theoretic optimality, Connections with CDMA multiuser detection and ISI equalization, Slow fading MIMO channel.

RBT Level: L2,L3

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or**oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks:

1. 'Digital Communications', John G. Proakis, Masoud Salehi, Pearson Education, ISBN:978-9332535893, 5thedition, 2014

2. 'Fundamentals of Wireless Communication', David Tse, Pramod Viswanath, Cambridge University Press, ISBN:0521845270, 1stedition, 2005

Reference Book:

'Digital Communication Systems', Simon Haykin, Wiley, ISBN:978-0471-64735-5, 2014

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=0b_jDaC7mCE

Skill Development Activities Suggested

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Describe models for fading channels, and concepts of diversity in time, frequency and space.	Explain
CO2	Explain the concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver	Understand
CO3	Evaluate the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.	Analyze
CO4	Develop &analyze schemes to improve performance in a multipath fading environment including maximal ratio combining, RAKE receivers, OFDM and MIMO	Analyze
CO5	Develop and evaluate the performance of a OFDM MIMO scheme to meet specified rate in a given multipath environment	Analyze

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**1**	**1**	**2**	**1**
CO2	**1**	**1**	**1**	**2**	**1**	**1**
CO3	**2**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**1**	**2**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

ERROR CONTROL CODING			
Course Code	**MLCS203**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Understand the concept of the Entropy, information rate and capacity for the discrete memoryless channel.
- Apply modern algebra and probability theory for the coding.
- Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes.
- Detect and correct errors for different data communication and storage systems.
- Analyze and implement different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm.

Module-1

Information theory: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem (Chap. 5 of Text 1).

Introduction to algebra: Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2m) and its properties, (Only statements of theorems without proof) Computation using Galois field GF (2m) arithmetic, Vector spaces and Matrices. **RBT Level: L1, L2, L3**

Module-2

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes.**RBT Level: L1, L2, L3**

Module-3

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes (Chap. 4 of Text2).**RBT Level: L1, L2, L3**

Module-4

BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. (6.1,6.2,6.7 of Text 2) Primitive BCH codes over GF (q),

Reed -Solomon codes

Majority Logic decodable codes: One -step majority logic decoding, Multiplestep majority logic (8.1,8.4 of Text 2).**RBT Level: L1, L2, L3**

Module-5

Convolution codes: Encoding of convolutional codes: Systematic and Non-systematic Convolutional Codes, Feedforward encoder inverse, Acatastrophic encoder, Structural properties of convolutional codes: state diagram, state table, state transition table, tree diagram, trellis diagram. Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding.**RBT Level: L1, L2, L3**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each

Suggested Learning Resources:

Textbooks:

1. 'Digital Communication systems', Simon Haykin, Wiley India Private. Ltd, ISBN 978-81-265-4231-4, First edition, 2014
2. 'Error control coding', Shu Lin and Daniel J. Costello. Jr, Pearson, Prentice Hall, 2nd edition, 2004

Reference Books:

1. 'Theory and practice of error control codes', Blahut. R. E, Addison Wesley, 1984
2. 'Introduction to Error control coding', Salvatore Gravano, Oxford University Press, 2007
3. 'Digital Communications - Fundamentals and Applications', Bernard Sklar, Pearson Education (Asia) Pvt. Ltd., 2nd Edition, 2001

Web links and Video Lectures (e-Resources):

Skill Development Activities Suggested

- NPTEL Course on Information Theory and Coding

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel.	Understand
CO2	Apply modern algebra and probability theory for the coding.	Apply
CO3	Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes.	Apply
CO4	Detect and correct errors for different data communication and storage systems.	Apply
CO5	Analyze and implement different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm	Apply

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication and Networking domain	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**-**	**1**	**1**	**-**	**1**
CO2	**1**	**-**	**1**	**1**	**-**	**1**
CO3	**1**	**-**	**1**	**1**	**-**	**1**
CO4	**1**	**-**	**1**	**1**	**-**	**1**
CO5	**1**	**-**	**1**	**1**	**-**	**1**

MULTIMEDIA OVER COMMUNICATION SYSTEM			
Course Code	**MLCS204**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Gain fundamental knowledge in understanding the basics of different multimedia networks, applications, media types like text and image.
- Analyze media types like audio and video and gain knowledge on multimedia systems.
- Analyze Audio compression techniques required to compress Audio.
- Analyze compression techniques required to compress video.
- Gain fundamental knowledge about the Multimedia Communications in different Networks.

Module-1

Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology.
RBT Level: L1, L2

Module-2

Information Representation: Introduction, Text, Images, Audio and Video.
Distributed multimedia systems: Introduction, main Features of a DMS, Resource management of DMS, Networking, and Multimedia Operating Systems. **RBT Level: L1, L2, L3, L4**

Module-3

Multimedia Processing in Communication: Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders.
RBT Level: L1, L2

Module-4

Multimedia Communication Standards: Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4.
RBT Level: L1, L2, L3

Module-5

Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks.**RBT Level: L1, L2, L3**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks:

1. Fred Halsall, "Multimedia Communications", Pearson education, 2001, ISBN -9788131709948.
2. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004. ISBN - 9788120321458.

Reference Books:

1. Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002, ISBN -9788177584417.

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc20_ph07/preview
https://www.classcentral.com/course/swayam-optical-communications-6699

Skill Development Activities Suggested

1. Features of Promodel Package and Input Modeling
2. Simulation of Manufacturing System I
3. Simulation of Manufacturing System II
4. Simulation of Service Operations I
5. Simulation of Service Operations II

Suggested Simulation Packages: Promodel

Note: A minimum of 5 exercises to be executed covering the entire syllabus in SDA

Course outcome (Course Skill Set)

Sl. No.	Description	Blooms Level
CO1	Understand basics of different multimedia networks and applications	Understand
CO2	Analyze media types like audio and video to represent in digital form.	Analyze
CO3	Understand different compression techniques to compress audio & video.	Understand
CO4	Describe the basics of Multimedia Communication Across Networks	Apply

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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's program	PO3
4	An ability to create, select, and apply appropriate techniques, resources, and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities, and norms of engineering.	PO5
6	An ability to recognize the need to engage in independent and lifelong learning in Digital Communication and Networking domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**2**	**2**	**-**	**-**	**-**
CO2	**2**	**2**	**2**	**-**	**-**	**2**
CO3	**2**	**2**	**1**	**-**	**1**	**2**
CO4	**2**	**2**	**1**	**-**	**1**	**2**

ADVANCED COMMUNICATION LABORATORY			
CourseCode	**MLCSL207**	CIEMarks	50
TeachingHours/Week(L:T:P: S)	3:0:0:0	SEE Marks	50
Credits	02	Total	100
		ExamHours	03

Courseobjectives: Thiscoursewillenablestudentsto:

- Understandandplot theradiationpatternofspecifiedantennasusingMATLABandwaveguidesetup.
- Determinecharacteristicsofagivenantenna.
- ComputetheS-parametersofMagic treeanddirectional couplers.
- TesttheICCD4051formodulationtechniques.
- 5.Understandthemultiplexingtechniquesusing OFCkit.

Sl.No.	Experiments
1	MATLAB/Complementationtoobtaintheradiationpatternofanantenna.
2	Studyofradiationpatternofdifferent antennas.
3	DeterminethedirectivityandgainsofHorn/Yagi/dipole/ Parabolicantennas.
4	ImpedancemeasurementsofHorn/Yagi/dipole/Parabolicantennas.
5	Studyofradiation patternofE&Hplanehorns.
6	SignificanceofPocklington'sintegralequation.
7	Studyofdigital modulationtechniquesusingCD4051IC.
8	Conductanexperiment forVoiceanddatamultiplexingusingOptical fiber.
	DemonstrationExperiments (For CIE)if any
9	Determinationofthemodestransittime,electronictimingrangeandsensitivityofKlystronsource.
10	DeterminationofVIcharacteristicsofGUNNdiode,andmeasurementofguidewavelength, FrequencyandVSWR.
11	Determinationofcouplingcoefficientandinsertionlossofdirectionalcouplersand Magictee.
12	Buildahardwarepseudo-randomsignal sourceanddeterminestatisticsofthegeneratedsignal source.

Note: Conduct the experiments using MATLAB/Scilab/any antenna simulation tool

Courseoutcomes(CourseSkill Set): Attheendofthe coursethestudentwill beableto:

1. Plot theradiationpatternofspecifiedantennasusingMATLABandwaveguidesetup.
2. Determinegainanddirectivityofagivenantenna.
3. ObtaintheS-parametersofMagicteeanddirectional couplers.
4. TesttheICCD4051formodulationtechniques.
5. ComprehendthemultiplexingtechniquesusingOFCkit.

Professional Elective-I

WIRELESS SENSOR NETWORKS			
Course Code	**MLCS215A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: Thiscoursewillenablestudentsto:

- Learn the basic concepts of Wireless sensor networks architecture and protocols.
- Understand the challenges in designing a Wireless sensor networks.
- Understand the function of Data link and Network layer Protocols.
- Understand the function of Transport layer Protocols.
- Analyze wireless sensor network system for different applications under consideration

Module-1

INTRODUCTION: Sensor Mote Platforms, WSN Architecture and Protocol Stack (Chap.1Text 1). WSN Applications: Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications.**RBT Level: L1, L2**

Module-2

FACTORS INFLUENCING WSN DESIGN: Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption (Chap. 3 Text 1). Physical Layer: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards.**RBT Level: L1, L2, L3**

Module-3

MEDIUM ACCESS CONTROL: Challenges for MAC, CSMA Mechanism, Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access (Chap. 5 of Text 1). Network Layer: Challenges for Routing, Data-centric and Flat Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols.**RBT Level: L1, L2**

Module-4

Transport Layer: Challenges for Transport Layer, Reliable Multi Segment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol, Event-to-Sink Reliable Transport (ESRT) Protocol, GARUDA

Application Layer: Source Coding (Data Compression), Query Processing, Network Management (Chap. 9 Text 1).**RBT Level: L1, L2, L3, L4**

Module-5

SPREAD SPECTRUM SIGNALS FOR DIGITAL COMMUNICATION: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS spread spectrum signals, generation of PN sequences, Frequency hopped spreadspectrum signals, Time hopping SS, Synchronization of SS systems.

RBT Level: L1, L2

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books:

1.Wireless Sensor Networks, Ian F. Akyildiz and Mehmet Can Vuran, John Wiley & Sons Ltd. ISBN 978-0-470-3601-3 (H/B),2010

2. Wireless Sensor Networks: Signal Processing and Communications Perspectives', Ananthram Swami, et.al, John Wiley & Sons Ltd., ISBN 978-0470-03557-3, 2007.

Web links and Video Lectures (e-Resources):

Massive Open Online Courses:

https://archive.nptel.ac.in/courses/106/105/106105160/#-**Wireless** Ad Hoc and **Sensor Networks** - BY Prof. SUDIP MISHRA,IITKGP

Skill Development Activities Suggested

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Implement Networking concepts using NS2/NS3/OMNET/OPNET/QUALNET software tool.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Acquire knowledge of characteristics of mobile/wireless communication channels	Understand
CO2	Apply statistical models of multipath fading	Apply
CO3	Understand the multiple radio access techniques, radio standards and communication protocols to be used for wireless sensor	Understand
CO4	Design wireless sensor network system for different applications under consideration.	Analyze
CO5	Understand the hardware details of different types of sensors and select right type of sensor for various applications	Understand

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication and Networking domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**-**	**1**	**3**	**-**	**2**
CO2	**1**	**-**	**1**	**3**	**-**	**2**
CO3	**1**	**-**	**1**	**3**	**-**	**2**
CO4	**1**	**1**	**1**	**3**	**-**	**2**
CO5	**1**	**1**	**1**	**3**	**-**	**2**

CRYPTOGRAPHY AND NETWORK SECURITY			
Course Code	**MLCS215B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(2:0:2)	SEE Marks	50
Total Hours of Pedagogy	30 Hours Theory+10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	3

Course outcomes: This course will enable students to:

- Understand the basics of symmetric key.
- Use basic cryptographic algorithms to encrypt the data.
- Generate some pseudorandom numbers required for cryptographic applications.
- Provide authentication and protection for encrypted data.
- Understand the techniques and features of Email, IP and Web security.

Module-1

Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms

SYMMETRIC CIPHERS: Traditional Block Cipher structure, Data Encryption Standard (DES), The AES Structure, AES Key Expansion. **RBT Level: L1, L2**

Module-2

More Number Theory: Prime Numbers, Fermat's and Euler's theorem, Testing for Primality, The Chinese Remainder theorem, Discrete Logarithms.

Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

RBT Level: L1, L2, L3

Module-3

Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP

RBT Level: L1, L2, L3

Module-4

One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA], One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes.

Digital Signature Algorithm, Discrete Logarithm Signature Scheme

RBT Level: L1, L2, L3

Module-5

E-mail Security: Pretty Good Privacy-S/MIME.

IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP)

.

Web Security: Web Security Considerations, SSL.

RBT Level: L1, L2

Assessment Details (both CIE and SEE)

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each

Suggested Learning Resources:

Textbooks:

1. "Cryptography and Network Security Principles and Practice", William Stallings, Pearson Education Inc., ISBN: 978-93325-1877-3, 6th Edition, 2015

2. "Applied Cryptography Protocols, Algorithms, and Source code in C", Bruce Schneier, Wiley Publications ISBN: 9971-51348-X, 2nd Edition

Reference Books:

1. "Cryptography and Network Security", Behrouz A. Forouzan, TMH, 2007

2. "Cryptography and Network Security", Atul Kahate, TMH, 200

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106105162
- Cryptography & Network Security, IIT Kharagpur, Prof. Sourav Mukophadhyay

Skill Development Activities Suggested

- Online certification course on probability and random process.
- Miniprojects can be suggested on the related area.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the basics of symmetric key.	Understand
CO2	Use basic cryptographic algorithms to encrypt the data.	Apply
CO3	Generate some pseudorandom numbers required for cryptographic applications.	Apply
CO4	Provide authentication and protection for encrypted data.	Apply

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication and	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**2**	**1**	**1**	**1**
CO2	**1**	**1**	**2**	**1**	**1**	**1**
CO3	**1**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**2**	**1**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

BIOMEDICAL SIGNAL PROCESSING			
Course Code	**MLCS215C**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 HoursTheory + 10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students:

- Model a biomedical system.
- Understand various methods of acquiring bio signals.
- Understand various sources of bio signal distortions and its remedial techniques.
- Analyze ECG and EEG signal with characteristic feature points.
- Understand use of bio signals in diagnosis, patient monitoring and physiological investigation.

MODULE-1

Introduction-Genesis and significance of bio electric potentials, ECG, EEG, EMG and their monitoring and measurement, Spectral analysis.

RBT Level: L1, L2

MODULE-2

Filtering- Digital and Analog filtering, Correlation and Estimation techniques, AR / ARMA models.

RBT Level: L1, L2

MODULE-3

ECG-Pre-processing, Measurements of amplitude and time intervals, Classification, QRS detection, ST segment analysis, Base line wander removal, waveform recognition, morphological studies and rhythm analysis, automateddiagnosis based on decision theory ECT compression, Evoked potential estimation.

RBT Level: L2, L3

MODULE 4

EEG: Evoked responses, Epilepsy detection, Spike detection, Hjorth parameters, averaging techniques, removal of Artifacts by averaging and adaptive algorithms, pattern recognition of alpha, beta, theta and delta waves in EEG waves, sleep stages.

RBT Level: L2, L3

MODULE 5

EMG-Wave pattern studies, bio feedback, Zero crossings, Integrated EMG. Time frequency methods and Wavelets in Biomedical Signal Processing.

RBT Level: L2,L3

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is

40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks.**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module

Textbook:'Biomedical Digital Signal Processing', Willis J Tompkins, Prentice Hall of India, 1996.

Reference Books:

1.'Biomedical Signal Processing (in IV parts)', R E Challis and RI Kitney, Medical and Biological Engg. And current computing, 1990-91.

2. Special issue on 'Biological Signal Processing', Proc. IEEE 1972.

3.'Biomedical Signal Processing', Arnon Cohen, Volumes I & II, CRC Press.

4.'Time frequency and Wavelets in Biomedical Signal Processing', Metin Akay, IEEE Press, 1999. Current Published literature.

Course outcome (Course Skill Set)At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Describe models for a biomedical system	Explain
CO2	Understand various methods of acquiring bio signals	Understand
CO3	Understand various sources of bio signal distortions and its remedial techniques.	Analyze
CO4	Analyze ECG and EEG signal with characteristic feature points	Analyze

CO5	Understand use of bio signals in diagnosis, patient monitoring and physiological investigation	Understand

Program Outcome of this course :

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**1**	**1**	**2**	**1**
CO2	**1**	**1**	**1**	**2**	**1**	**1**
CO3	**2**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**1**	**2**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

ADVANCES IN IMAGE PROCESSING			
Course Code	**MLCS215D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 HoursTheory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students:

1. Understand the representation of the digital image and its properties.
2. Apply pre-processing techniques required to enhance the image for its further analysis.
3. Use segmentation techniques to select the region of interest in the image for analysis.
4. Represent the image based on its shape and edge information and also describe the objects present in the image based on its properties and structure.
5. Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

MODULE-1

The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.

RBT Level: L1, L2

MODULE-2

Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.

RBT Level: L1, L2

MODULE-3

Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.

RBT Level: L1, L2

MODULE 4

Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using

segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.

RBT Level: L2, L3

MODULE 5

Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds. **RBT Level: L1,L3**

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Text Book:

'Image Processing, Analysis, and Machine Vision', Milan Sonka, Vaclav Hlavac, Roger Boyle, Cengage Learning, ISBN: 978-81-315-1883-0, 2013

Reference Books:

1. 'Digital Image Processing for Medical Applications', Geoff Doughertry, Cambridge university Press, 2010.

2. 'Digital Image Processing', S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2011.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the representation of the digital image and its properties.	Understand
CO2	Apply pre-processing techniques required to enhance the image for its further analysis.	Understand
CO3	Use segmentation techniques to select the region of interest in the image for analysis.	Understand
CO4	Represent the image based on its shape and edge information and also describe the objects present in the image based on its properties and structure.	Understand
CO5	Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects	Apply

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**1**	**1**	**2**	**1**
CO2	**1**	**1**	**1**	**2**	**1**	**1**

CO3	**2**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**1**	**2**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

Professional Elective-II

STATISTICAL SIGNAL PROCESSING			
Course Code	**MLCS216A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 Hours Theory+10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives: Thiscoursewillenablestudentsto

- Understandrandomprocessesanditsproperties
- Understandthebasictheoryofsignaldetectionandestimation
- Identifytheengineeringproblemsthatcanbeputintotheframeofstatisticalsignal processing
- Solvetheidentifiedproblemsusingthestandardtechniqueslearnedthroughthiscourse.
- Makecontributionstothetheoryandthepracticeofstatisticalsignalprocessing.

Module-1

RandomProcesses: Randomvariables,randomprocesses,white noise, filtering random processes, spectral factorization,ARMA,ARandMAprocesses.**RBT Level: L1, L2, L3, L4**

Module-2

Signal Modeling: Least squares method, Pade approximation,Prony'smethod,finitedatarecords,stochasticmodels,Levinson-Durbinrecursion;Schurrecursion;Levinson recursion (Text1).**RBT Level: L1, L2, L3**

Module-3

SpectrumEstimation: Nonparametricmethods,minimum-variancespectrumestimation,maximumentropymethod,parametricmethods,frequencyestimation,principalcomponentsspectrumestimation (Text1).**RBT Level: L1, L2**

Module-4

Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms, adaptive recursive filters, RLS algorithms (Text 1).**RBT Level: L1, L2**

Module-5

ArrayProcessing: Arrayfundamentals,beam-forming,optimumarrayprocessing,performanceconsiderations,adaptivebeam-forming,linearlyconstrainedminimum-variancebeam-formers,side-lobecancellers.**RBT Level: L1, L2**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Text Books

1. MonsonH.Hayes,"StatisticalDigitalSignalProcessingandModeling",JohnWiley&Sons (Asia)Pvt.Ltd.,2002.
2. DimitrisG.Manolakis,VinayK.Ingle,andStephenM.Kogon,"StatisticalandAdaptiveSignalProcessing:SpectralEstimation,Signal Modeling, Adaptive Filtering and Array Processing" ,McGraw-HillInternationalEdition,2000.

Web links and Video Lectures (e-Resources):

Skill Development Activities Suggested

- Mathematical modeling of signals: linear vs. nonlinear, deterministic signals, random signals, unknown parameters.
- Mathematical modeling of noise: white Gaussian noise, coloured Gaussian noise, general Gaussian noise, IID non-Gaussian noise.
- Specific algorithms for estimation, detection, and spectral estimation: parameter estimation, signal extraction, adaptive filtering, sinusoidal estimation, matched filters, estimator-correlator, spectral estimation via Fourier and high-resolution methods.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO 1	DesignstatisticalDSPalgorithmstomeetdesiredneeds	Analyze
CO 2	Applyvectorspacemethodstostatisticalsignalprocessingproblems	Apply
CO 3	Identifytheengineeringproblemsthatcanbeputintotheframeofstatistical signal processing	Understand
CO 4	UnderstandWienerfiltertheoryanddesigndiscreteandcontinuousWienerfilters	Understand
CO	UnderstandKalmanFiltertheoryanddesigndiscretetoKalmanfilters	Understan

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication and Networking domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**	**2**	**3**	**-**	**3**
CO2	**2**	**3**	**3**	**-**	**3**	**3**
CO3	**2**	**2**	**-**	**3**	**3**	**2**
CO4	**3**	**2**	**3**	**-**	**-**	**3**
CO5	**3**	**3**	**3**	**3**	**-**	**3**

ARRAY SIGNAL PROCESSING			
Course Code	**MLCS216B**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 HoursTheory + 10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students:

1. Comprehend the basics of signals in space and time.
2. Understand the important concepts of array signal processing.
3. Describe the various array design techniques.
4. Understand the basic principle of direction of arrival estimation techniques.
5. Explain the Concepts of Spatial Frequency along with the Spatial Samplings.

MODULE-1

Spatial Signals: Signals in space and time, Spatial Frequency vs Temporal Frequency, Review of Co-ordinate Systems, Maxwell's Equation, Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system –Wave number vector, Slowness vector.

RBT Level: L1, L2

MODULE-2

Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.

RBT Level: L1, L2

MODULE-3

Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.

RBT Level: L1, L2

MODULE 4

Scaling Laws in Miniaturization:

Uniform Linear Arrays: Beam pattern in θ, u and ψ -space, Uniformly Weighted Linear Arrays.

Beam Pattern Parameters: Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering.

RBT Level: L2, L3

MODULE 5

Array Design Methods: Visible region, Duality between Time -Domain and Space -Domain Signal Processing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward - Lawson Frequency-Sampling Design.

Non parametric method -Beam forming, Delay and sum Method, Capons Method.

RBT Level: L1,L2

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Text Book:

'Optimum Array Processing Part IV of Detection, Estimation, and Modulation Theory', Harry L. Van Trees, John Wiley & Sons, ISBN: 9780471093909, 2002.

Reference Books:

1. 'Array Signal Processing: Concepts and Techniques', Don H. Johnson, Dan E. Dugeon, Prentice Hall Signal Processing Series, 1st Edition, ISBN-13: 978-0130485137.

2. 'Spectral Analysis of Signals', PetreStoica and Randolph L. Moses, Prentice Hall, ISBN: 0-13-113956-8, 2005.

3. 'Electromagnetic Waves and Antennas', Sophocles J. Orfanidis, ECE Department, Rutgers University, 94 Brett Road Piscataway, NJ 88548058. http://www.ece.rutgers.edu/~orfanidi/ewa/ISBN: 0-07-114243-64, 2003.

2. "Real-Time Concepts for Embedded Systems", Qing Li and Carolyn Yao, CMP Books, ISBN:1578201241, 2003.

3. "Real Time Systems", Jane W. S. Liu, Prentice Hall, ISBN: 0130996513, 2000.

4. "Real-Time Systems Design and Analysis", Phillip A. Laplante, John Wiley & Sons, 2004.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Comprehend the basics of signals in space and time.	Understand
CO2	Understand the important concepts of array signal processing.	Understand
CO3	Describe the various array design techniques.	Understand
CO4	Understand the basic principle of direction of arrival estimation techniques.	Understand
CO5	Explain the Concepts of Spatial Frequency along with the Spatial Samplings.	Understand

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	1
CO2	1	1	1	2	1	1
CO3	1	1	2	1	1	1
CO4	2	1	1	2	1	1
CO5	1	1	2	1	1	1

MICRO ELECTRO MECHANICAL SYSTEMS			
Course Code	**MLCS216C**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 HoursTheory + 10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students:

- Understand the technologies related to Micro Electro Mechanical Systems.
- MEMS devices analyses and develop suitable mathematical models
- Understanding of application areas for MEMS devices
- Fabrication processes involved with MEMS devices.

MODULE-1

Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.

RBT Level: L1, L2

MODULE-2

Working Principles of Microsystems: Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics.

Engineering Science for Microsystems Design and Fabrication:

Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.

RBT Level: L1, L2

MODULE-3

Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite

Element Stress Analysis.**RBT Level: L2, L3**

MODULE 4

Scaling Laws in Miniaturization:

Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.

RBT Level: L2, L3

MODULE 5

Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micromanufacturing.

Microsystem Design: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.

RBT Level: L3,L4

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module

Text Book:

'MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering', Tai-Ran Hsu, John Wiley & Sons, ISBN: 978-0470-08301-7,2nd Edition, 2008

Reference Books:

1. 'Micro and Nano Fabrication: Tools and Processes', Hans H. Gatzen, Volker Saile, Jurg Leuthold, Springer, 2015

2. 'Micro Electro Mechanical Systems (MEMS)', Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Cengage Learning.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the technologies related to Micro Electro Mechanical Systems.	Understand
CO2	Relate to the scaling laws in miniaturization.	Understand
CO3	Analyse the MEMS devices and develop suitable mathematical models	Analyze
CO4	Understand the various application areas for MEMS devices	Understand
CO5	Describe the design and fabrication processes involved with MEMS devices.	Understand

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the	PO5

	engineering.	
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**1**	**1**	**2**	**1**
CO2	**1**	**1**	**1**	**2**	**1**	**1**
CO3	**2**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**1**	**2**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

WAVELET TRANSFORMS AND APPLICATIONS			
Course Code	**MLCS216D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 HoursTheory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students:

1. 1 Classify various wavelet transform and explain importance of it.
2. Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT).
3. Explain the properties and application of wavelet transform.
4. Develop and realize computationally efficient wavelet-based algorithms for signal and image processing.
5. Explain brief features and strength of transform beyond wavelet. .

MODULE-1

Continuous Wavelet Transform: Continuous time frequency representation of signals, The Windowed Fourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, specifications, admissibility conditions, Continuous wavelet transform, CWT as a correlation, CWT as an operator, Inverse CWT.

MODULE-2

Discrete wavelet Transform: Approximations of vectors in nested linear vector spaces, Example of an MRA, Formal definition of MRA, Construction of genera orthonormal MRA, a Wavelet basis for MRA, Digital filtering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm Filter

bank implementation of DWT.

RBT Level: L1, L2

MODULE-3

Alternative wavelet representations- Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets, biorthogonal analysis and synthesis, Filter bank implementation, Two dimensional Wavelets, filter bank implementation of two-dimensional wavelet transform.

RBT Level: L1, L2

MODULE 4

Lifting scheme: Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme, lifting scheme in the z- domain, mathematical preliminaries for polyphase factorization, Dealing with Signal Boundary.

RBT Level: L2, L3

MODULE 5

Applications: Image Compression: EZW Coding, SPIHT, Wavelet Difference Reduction Compression Algorithm, Denoising, speckle removal, edge detection and object isolation, audio compression, communication applications – scaling functions as signalling pulses, Discrete Wavelet Multitone Modulation. **Beyond Wavelet:** Ridge lets and curve lets: Ridge let transform and Digital Curve let transform, Curve let construction, Properties and applications.

RBT Level: L1,L2,L3

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately

reduced to 50.

2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module

Textbook:

1. Wavelet Transforms –Introduction and applications - Raguveer M. Rao and Ajit S. Bopardikar- - Pearson Education, 2008

2. Insight into Wavelets from Theory to practice - K.P Soman, K. I. Ramachandran, PHI, 2006

3. Fundamentals of Wavelets: Theory, Algorithms and Applications- J C Goswamy and A K Chan, WileyInderscience Publications, John Wiley and Sons, 1999.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Classify various wavelet transform and explain importance of it.	Understand
CO2	Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT).	Understand
CO3	Explain the properties and application of wavelet transform.	Analyze
CO4	Develop and realize computationally efficient wavelet-based algorithms for signal and image processing.	Apply
CO5	Explain brief features and strength of transform beyond wavelet.	Analyze

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	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	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**1**	**1**	**1**	**2**	**1**
CO2	**1**	**1**	**1**	**2**	**1**	**1**
CO3	**2**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**1**	**2**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

ABILITY/SKILL ENHANCEMENT COURSE (OFFLINE/ONLINE)

Modelling and Simulation of Antenna Using Simulation Tool			
Course Code	MLCSL258A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0 / 1:0:0:0	SEE Marks	50
		Total	100
Credits	1	Exam Hours	02

Course objectives:

- Understand the basic concepts of antenna theory.
- Identify antenna types for specific applications.
- To design antennas like dipole, Yagi-Uda, Microstrip patch antenna, MIMO antenna, Helical antennas and other broad band antennas
- To describe different antenna synthesis methods.

Sl.NO	Experiments
1	Design and simulate 1 GHz dipole antenna using suitable high frequency simulation tool, for return loss and gain characteristics.
2	Create and simulate a 5 element Yagi-Uda antenna using a copper wire with given data (a) Resonance frequency of 3 GHz (b) wire diameter of 1 mm. Study return Loss (RL) and gain characteristics
3	Design, model and simulate microstrip patch antenna at 2.45 GHZ for blue-tooth applications. Study its radiation pattern in terms of E and H plane.
4	Design, model and simulate 2 element MIMO antennas for 5G applications in Frequency Range-1. Perform isolation analysis and return loss characterization.
5	Design, model and simulate 4 element array antennas for a suitable frequency and study (a) Return loss characteristics (b) gain (c) radiation pattern.
6	Design, model and simulate normal mode helical antenna (NMHA) at 1.8 GHz. Study its return loss characteristics and effect of wire radius (between $\lambda/180$ to $\lambda/120$) on Bandwidth.
7	Design and simulate horn antenna at 2 GHz with a suitable simulator. Study its return loss Characteristics. Observe E-field, H-field and surface current distribution.
8	Design and simulate a parabolic reflector antenna for a suitable frequency with efficiency at 50%. Find reflection coefficient and gain in DB by plotting radiation pattern.
9	Design, Model and Simulate a log periodic (or planar) antenna at 5 GHz. Study its radiation characteristics and gain.
10	Design and Analyze VHF/UHF Biconical Antenna. Study its reflection coefficient, bandwidth and Radiation pattern at 300MHz, 600 MHz and 1000 MHz.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Analyze various antenna parameters and their significance in building the RF system.
- Identify various antenna configurations for suitable applications.
- Design antennas like Yagi-Uda, Helical antennas and other broad band antennas
- Describe different antenna synthesis methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marksis scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

- https://pe.gatech.edu/courses/modeling-and-simulation-antennas
- https://www.eledia.org/eledia-unitn/news/antenna-modeling-and-simulation-made-easy-fundamentals-and-hands-on-exercises-2/
- https://www.tonex.com/training-courses/modeling-and-simulation-of-modern-antennas/
- https://innovationspace.ansys.com/product/electromagnetic-simulation-of-an-antenna-using-ansys-discovery/

MATLAB and Simulink			
Course Code	MLCSL258B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0 / 1:0:0:0	SEE Marks	50
		Total	100
Credits	1	Exam Hours	02

Course objectives:

- To provide skills for modelling and simulation of communication systems & networks on MatLab platform.
- To provide skills for writing MatLab programs and use communication and signal processing toolboxes.
- To enable the students to implement and validate the algorithms studied in Communication.

Sl. No	Experiments
1	Familiarity with MatLab communication and signal processing toolbox.
2	Programs to generate uniformly distributed random variables between [0, 1] using Linear Congruential Generator.
3	Programs to generate discrete random variables based on inverse transform technique.
4	Programs to generate discrete random variables based on acceptance rejection technique.
5	Programs to validate random variable generators based on KS test.
6	Programs to validate random variable generators based on Chi square test.
7	Programs to validate independence of random variable generators based on Runs test.
8	Programs to validate independence of random variable generators based on Autocorrelation test.
9	Programs to use Monte Carlo techniques to estimate parameters of quantities used in communication system.
10	Designing the digital communication system to evaluate BER vs. SNR performance

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Identify and abstract the simulation model design of communication systems.
- Design and develop modular programming skills on MatLab platform.
- Trace, debug and validate simulation models.
- Able to implement the algorithms required for discrete event simulation.
- Able to implement the validation tests for discrete event simulation models.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marksis scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

- https://www.udemy.com/course/simulink/
- https://in.mathworks.com/learn/training.html
- https://www.nielit.gov.in/calicut/content/online-course-matlab-simulink
- https://www.coursera.org/courses?query=matlab%20simulink

Python Programming			
Course Code	MLCSL258C	CIE Marks	50
Teaching Hours/Week (L:T:P)	**0:2:0**	SEE Marks	50
Credits	**01**	Total Marks	100
		Exam Hours	02

Course objectives:

To provide skills for modelling and simulation of communication systems & networks on MatLab platform.
To provide skills for writing MatLab programs and use communication and signal processing toolboxes.
To enable the students to implement and validate the algorithms studied in Communication.
To enable the students to implement and validate the algorithms studied in Communication.

Sl.NO	Experiments
1.	Write a Python program that calculates the sum of the first n terms of the following mathematical series: $1-\frac{x^2}{2!}+\frac{x^4}{4!}-\frac{x^6}{6!}....\frac{x^n}{n!}$
2.	Write a Python program that reads a file and calculates the number of characters, words, and lines in it.
3.	Write a Python program to compute various matrix and vector operations such as dot product, inner product, outer product, and matrix exponentiation.
4.	a) Write a Python program that uses Pandas' built-in visualization tools to create the following plots: • Bar plots • Histograms • Line plots • Scatter plots b) Write a program to demonstrate the use of the groupby() method in Pandas. c) Write a program that shows how to merge, join, and concatenate dataframes in Pandas. d) Write a Python program to create dataframes from CSV and Excel files.
5.	Write a python program to check the validity of a password given by the user. The password should satisfy the following criteria: a) Contain at least 1 letter between a and z b) Contain at least 1 number between 0 and 9 c) Contain at least 1 letter between A and Z d) Contain at least 1 character from $, #, @ e) Minimum length of password: 6 f) Maximum length of password: 12
6.	Write a Python program that performs basic database operations (create, insert, delete, update) using MySQL and its corresponding Python adapter
7.	Write a Python program that accepts a space-separated sequence of words as input and outputs the words in a hyphen-separated sequence after sorting them alphabetically.
8.	Write a Python program that demonstrates data indexing, selection, and filtering using Pandas.
9.	a) Write a Python GUI application that simulates traffic lights with appropriate colors and text for "Stop", "Wait", and "Go" signals. b) Write a python program for simple GUI calculator using Tk.
10.	Create a Python class named Person with attributes for name, age, weight (in kg), and height (in feet). The class should have a method get_bmi_result() that calculates the BMI and returns whether the person is "underweight", "healthy", or "obese"
11.	Write a Python program to demonstrate various types of inheritance.
12.	Write a Python program that creates abstract classes and implements abstract methods.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Students will be able to design and implement Python programs that solve complex problems, including mathematical series, file handling, matrix operations, and more.
- Students will be capable of effectively managing and analyzing datasets using Python libraries like Pandas and

NumPy, and visualizing the data through bar plots, histograms, line plots, and scatter plots.
- Students will demonstrate the ability to connect Python programs to MySQL databases, perform CRUD (Create, Read, Update, Delete) operations, and manage database interactions proficiently.
- Students will be able to apply object-oriented programming concepts like inheritance and abstraction, and develop interactive GUI applications using Tkinter, enhancing the user experience in software solutions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marksis scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 03 hours

Suggested Learning Resources:

- R. Nageswara Rao , "Core Python Programming" Dreamtech Press India Pvt Ltd 2018.
- https://onlinecourses.nptel.ac.in/noc19_cs40/preview
- https://onlinecourses.nptel.ac.in/noc19_cs41/preview