ADVANCED ENGINEERING MATHEMATICS		Semester	1
Course Code	**22LAC11**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Toknowtheanalysisofdiscretetimesignals.
- Tostudythemoderndigitalsignal processingalgorithmsandapplications.
- ToHaveanin-depthknowledgeof useofdigitalsystemsinrealtimeapplications
- Toapplythealgorithms forwideareaofrecentapplications.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

Module-1

LinearAlgebra-I

Introduction to vector spaces and sub-spaces, definitions, illustrative example.Linearly independent and dependent vectors- Basis-definition and problems.Lineartransformations-definitions.Matrixformoflineartransformations-Illustrativeexamples

Module-2

LinearAlgebra-II

Computation of eigen values and eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidtorthogonalizationprocess

Module-3

CalculusofVariations

Conceptoffunctional-Eulersequation.Functionaldependentonfirstandhigherorderderivatives,Functionalonseveraldependentvariables.Isoperimetricproblems-variationproblemswithmovingboundaries.

Module-4

Probability Theory: Review of basic probability theory. Definitions of randomvariables and probability distributions, probability mass and density functions,expectation, moments, central moments, characteristic functions, probabilitygenerating andmoment generatingfunctions-illustrations.Poisson,Gaussianand Erlangdistributionsexamples

Module-5

Engineering Applications on Random processes: Classification. Stationary,WSSandergodicrandomprocess.Auto-correlationfunction-properties,Gaussianrandomprocess

Course outcome (Course Skill Set)

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

1. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.

2. Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.

3. Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.

4. Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.

5. Analyze random process through parameter-dependent variables in various random processes.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks.**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs andPOs.

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. TheSEE questionpaperwillbesetfor100 marksandthemarksscoredwill beproportionatelyreducedto50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Textbooks:

1. 'LinearAlgebraanditsApplications',DavidCLay,StevenRLayandJJMcDonald, PearsonEducationLtd., 5th Edition, 2015
2. 'DifferentialEquationsandCalculusofVariations',ElsgoltsL,MIRPublications, 3rd Edition,1977
3. 'Probability,StatisticsandRandomProcess',TVeerarajan,TataMc-GrawHillCo.,3rd Edition,2016

Suggested Learning Resources:

Books

1. David M. Pozar – Microwave Engineering, 4th Edition, John Wiley & Sons, Inc. 2013
2. E C Jordan and K G Balmain - Electromagnetic Waves and Radiating Systems, 2nd Edition, PHI, 2003.

ReferenceBooks:

1. 'IntroductiontoLinearAlgebra',GilbertStrang,Wellesley-CambridgePress, 5th Edition,2016
2. 'Schaum'sOutlinesofTheoryandProblemsofMatrixOperations',Richard Bronson,McGraw-Hill,1988
3. 'Probability and Random Process with application to Signal Processing',Scott L Miller, Donald G Childers, Elsevier Academic Press, 2nd Edition,2013

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=V7qyku_7hM0&list=PLbMVogVj5nJSgrtwLEfYZIlrglCXYxgdo&index=1
https://www.youtube.com/watch?v=4A3b8zORlg4&list=PLbMVogVj5nJSgrtwLEfYZIlrglCXYxgdo&index=2
https://www.youtube.com/watch?v=6Zacf25sXhk&list=PLbMVogVj5nJSgrtwLEfYZIlrglCXYxgdo&index=6

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

- Students can prepare innovative mathematical modelling of different simple communication modules

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	-	-	-	-	-	1	-	3
CO2	3	3	1	1	3	-	-	-	-	1	-	3
CO3	3	3	1	1	3	-	-	-	-	1	-	3
CO4	3	3	1	2	-	-	-	-	-	1	-	3
CO5	3	3	1	2	2	-	-	-	-	1	-	3

ADVANCEDDIGITALSIGNALPROCESSING		Semester	1
Course Code	**22LAC12**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 HoursTheory+ 10-12 Lab	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory + Lab		

Course objectives:

- Toknowtheanalysisofdiscretetimesignals.
- Tostudythemoderndigitalsignal processingalgorithmsandapplications.
- ToHaveanin-depthknowledgeof useofdigitalsystemsinrealtimeapplications
- Toapplythealgorithms forwideareaofrecentapplications.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method,

Seminar
MODULE-1
Introduction to Digital Signal Processing: Review of Discrete time signals and systems and frequencyanalysis of discrete time linear time invariant systems, implementation of discrete time systems, correlation ofdiscrete timesystemsSampling,decimationby a factor 'D',Interpolationby afactor 'I',sampling rateconversionbyafactor'I/D',Implementationofsamplingrateconversion,Multistageimplementationof samplingrateconversion.
MODULE-2
Multirate Digital Signal Processing: Multirate signal processing and its applications, Design of Digital filters,DesignofFIRfilters,DesignofIIRfilters,frequencytransformations,Digitalfilterbanks,twochannel quadraturemirrorfilterbanks,M channelQMFbank.
MODULE-3
Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations. The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters.
MODULE-4
Adaptivefilters: **ApplicationsofAdaptiveFilters**-AdaptiveChannelEqualization,Adaptivenoisecancellation,LinearPredictive coding of Speech Signals, Adaptive direct form FIR filters-The LMS algorithm, Properties of LMSalgorithm.Adaptivedirectformfilters-RLSalgorithm.
MODULE-5
PowerSpectrumEstimation: **Non parametric Methods for Power Spectrum Estimation** - Bartlett Method, Welch Method, Blackman&TukeyMethods. **Parametric Methods for Power Spectrum Estimation:** Relationship between the auto correlation and themodel parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Modelparameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methodsforthe ARModelparameters, ARMA ModelforPower SpectrumEstimation.

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

Sl.NO	Experiments
1	Generatevariousfundamentaldiscretetimesignals
2	Basicoperationsonsignals(Multiplication,Folding,Scaling).
3	Findout theDFT &IDFTofagivensequencewithout usinginbuiltinstructions.

4	Interpolation&decimationofagivensequence.
5	GenerationofDTMF(DualToneMultipleFrequency)signals
6	EstimatethePSDofanoisysignalusingperiodogramandmodified periodogram
7	EstimationofPSDusingdifferent methods(Bartlett,Welch,Blackman-Tukey).
8	DesignofChebyshevTypeI,IIFilters.
9	CascadeDigital IIRFilterRealization.
10	ParallelRealizationofIIRfilter.
11	Estimationofpowerspectrumusingparametricmethods (YuleWalker&Burg).
12	Time-FrequencyAnalysiswiththeContinuousWaveletTransform.

Course outcomes (Course Skill Set):

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

- Able to analyze and implement the frequency analysis & correlation of discrete-time linear time invariant systems.
- Able to implement sampling rate conversion by decimation & Interpolation process and design digital filter banks
- Able to analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm
- Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm.
- Able to understand parametric & non-parametric methods for power spectrum estimation.

AssessmentDetails(bothCIE andSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

CIEforthe theorycomponent of IPCC

1. TwoTests each of **20 Marks**
2. Twoassignmentseachof **10Marks/OneSkillDevelopmentActivityof20marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60marks,marks scored willbeproportionallyscaled down to**30marks**.

CIEforthe practical component ofIPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated andmarks shall be awarded on the same day.The **15 marks** are for conducting the experiment andpreparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end ofthesemester.
- The CIE marks awarded in the case of the Practical component shall be based on the

continuousevaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of allexperiments'write-ups areaddedand scaled downto 15marks.

- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marksandscaled downto 05 marks**.**

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

SEEfor IPCC

TheorySEEwill beconductedbyUniversityasperthescheduled timetable,withcommon questionpapersforthecourse (duration 03Hours)

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50marks.

1. Thequestionpaper will havetenquestions.Eachquestionisset for20marks.
2. Therewillbe2questionsfromeachmodule.Eachofthetwoquestionsunderamodule(withamaximumof3 sub-questions),**shouldhave amixoftopics**under thatmodule.
3. Thestudents have toanswer 5 fullquestions,selectingonefullquestion fromeachmodule.

Thetheory portionof theIPCCshallbefor bothCIEandSEE,whereasthepracticalportionwillhaveaCIE component only. Questions mentioned in the SEE paper shall include questions from the practicalcomponent).

- 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. Thelaboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from thelaboratorycomponentshallbeincluded**.**Themaximumof04/05questionstobesetfromthepractical componentofIPCC,thetotalmarksof allquestionsshouldnot bemorethanthe20marks.
- SEEwillbeconductedfor100marksandstudentsshallsecure40%ofthemaximummarkstoqualifyintheSE E.Markssecuredwillbescaleddownto50.(Studenthastosecureanaggregateof50%of maximummarksof thecourse(CIE+SEE)

Suggested Learning Resources:

Books

Text Books

1. **Digital Signal Processing Principles, Algorithms, and Applications by John G. Proakis, Prentice-Hall InternationalInc.,4th Edition, 2012.**
2. **Theory and Application of Digital Signal Processing by Lawrence R. Rabiner and Bernard Gold.ReferenceBooks**
1. **Oppenheim,AlanV.Discrete-timesignal processing.PearsonEducationIndia,1999.**
2. **Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer-based approach.Volume2. NewYork: McGraw-HillHigher Education, 2006.**

WeblinksandVideoLectures(e-Resources):

- **https://ekeeda.com/degree-courses/electrical-engineering/advanced-digital-signal-processing**
- **https://dss-kiel.de/index.php/teaching/lectures/lecture-advanced-digital-signal-processing**

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning **MiniProject inthe areaAdvancedsignalprocessing usingmodern tools likeMATLAB,Python**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1	-	-	-	-	-	-	-	2
CO2	3	3	3	-	3	-	-	-	-	-	-	2
CO3	1		2	-	3	-	-	-	-	-	-	2
CO4	1			1	-	-	-	-	-	-	-	1
CO5	1			-	2	-	-	-	-	-	-	1

ADVANCEDCOMMUNICATIONSYSTEM1		Semester	1
Course Code	**22LAC13**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	04	Exam Hours	3
Examination type (SEE)	Theory		

CourseLearningobjectives: Thiscourse will enablestudents:

- Toknowmodulationtechniques.
- Tostudythe demodulationtechniques.
- ToHaveanin-depthknowledgeofbandlimitedchannelsandequalizers
- Tounderstandspreadspectrum.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

Module-1

Signal Representation: Low pass representation of bandpass signals, Low pass representation of bandpassrandom process [Text 1, Chapter 2:2.1, and 2.9 only]. **Modulation**: Representation of digitally modulatedSignals,ModulationSchemeswithoutmemory(BandLimitedSchemes-PAM,BPSK,QPSK,MPSK,MQAM, Power Limited Schemes – FSK, MFSK, DPSK, DQPSK), modulation schemes with memory (BasicsofCPFSKandCPM –FullTreatment ofMSK),Transmit PSDforModulation Schemes.

Module-2

Demodulation:VectorChannel,VectorChannel+AWGN,Performanceparameters,OptimumCoherentDetection for power limited and Bandlimited schemes, Optimal Coherent detection for schemes with memory,OptimalNon–Coherentdetectionforschemeswithoutandwithmemory(FSK,DPSK,DQPSK),Comparison ofdetectionschemes.

Module-3

Bandlimited Channels: Bandlimited channel characterization, signaling through band limited linear filterchannels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes, Optimum receiver for channel withISI and AWGN. **Linear Equalizers**: Zero forcing Equalizer, MSE and MMSE, Baseband and Passband LinearEqualizers.Performance ofZFEand MSE.

Module-4

Non-LinearEqualizers:Decision -feedbackequalization,PredictiveDFE,PerformanceofDFE.

Adaptiveequalization:Adaptivelinearequalizer,adaptivedecisionfeedbackequalizer,AdaptiveFractionallyspacedEqualizer(TapLeakageAlgorithm), AdaptiveequalizationofTrellis-coded signals

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 spread spectrum signals, Time hopping SS, Synchronization of SS systems.

AssessmentDetails(bothCIE andSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

CIEforthe theorycomponent of IPCC

4. TwoTests each of **20 Marks**
5. Twoassignmentseachof **10Marks/OneSkillDevelopmentActivityof20marks**
6. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60marks,marks scored willbeproportionallyscaled down to**30marks**.

CIEforthe practical component ofIPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated andmarks shall be awarded on the same day.The **15 marks** are for conducting the experiment andpreparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end ofthesemester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuousevaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of allexperiments'write-ups areaddedand scaled downto 15marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marksandscaled downto 05 marks**.**

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

SEEfor IPCC

TheorySEEwill beconductedbyUniversityasperthescheduled timetable,withcommon questionpapersforthecourse (duration 03Hours)

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50marks.

4. Thequestionpaper will havetenquestions.Eachquestionisset for20marks.
5. Therewillbe2questionsfromeachmodule.Eachofthetwoquestionsunderamodule(withamaximumof 3 sub-questions),**shouldhave amixoftopics**under thatmodule.
6. Thestudents have toanswer 5 fullquestions,selectingonefullquestion fromeachmodule.

Thetheory portionof theIPCCshallbefor bothCIEandSEE,whereasthepracticalportionwillhaveaCIE component only. Questions mentioned in the SEE paper shall include questions from the practicalcomponent).

- 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. Thelaboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from thelaboratorycomponentshallbeincluded**.**Themaximumof04/05questionstobesetfromthepracti cal componentofIPCC,thetotalmarksof allquestionsshouldnot bemorethanthe20marks.
- SEEwillbeconductedfor100marksandstudentsshallsecure40%ofthemaximummarkstoqualifyint heSEE.Markssecuredwillbescaleddownto50.(Studenthastosecureanaggregateof50%of maximummarksof thecourse(CIE+SEE)

Suggested Learning Resources:

Textbook:

'DigitalCommunications',JohnG.Proakis,MasoudSalehi,PearsonEducation,ISBN:978-

9332535893,5thedition,2014

ReferenceBooks:

1. 'DigitalCommunications:FundamentalsandApplications:Fundamentals&Applications',Bernard Sklar,PearsonEducation, ISBN:9788131720929, 2nd edition, 2009
2. DigitalCommunicationsSystems',SimonHaykin,Wiley,ISBN:9788126542314,1stedition, 2014

Web links and Video Lectures (e-Resources):

- https//nptel.ac.in/courses/11706087/
- https://nptel.ac.in/courses/106/106/106106198/
- https://nptel.ac.in/courses/117102059/

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

- Students will do mini project in related Domain

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	2	-	-	1
CO2	3	3	3	2	2	1	-	-	2	-	-	1
CO3	3	3	3	3	3	1	-	-	2	-	-	1
CO4	3	3	3	3	3	1	1	-	2	-	-	1
CO5	3	3	3	3	2	2	2	-	2	-	-	1

ADVANCEDENGINEERING ELECTROMAGNETICS		Semester	1
Course Code	**22LAC14**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

Thiscourse will enablestudents:

- To introduce the basic mathematical concepts related to electromagnetic vector fields.
- To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.
- To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday‘s law, induced emf and Maxwell‘s equations.
- To impart knowledge on the concepts of Concepts of electromagnetic waves and Transmission lines.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

Vector Analysis: Review of vector algebra, Review of cartesian, Cylindrical and spherical coordinate systems, Introduction to del (operator, Use of del operator as gradient, divergence, curl).

Smith Chart: Description and detailed analysis

Module-2

Electrostatic fields: Introduction to coulomb’s law, Gaussian law and its applications in determination of field of spherical and cylindrical geometries, Laplace’s and poission’s equation in various coordinate systems. Effect of dielectric on capacitance, Boundary conditions at electric interfaces, Method of images and its applications.

Module-3

Magnetostatics: Introduction to ampere’s law, Magnetic vector potential, Magnetic forces, Boundary conditions at magnetic interfaces.

Module-4

Time Varying Fields and Maxwell's Equations: Continuity of charge, Concept of displacement current, Maxwell's equation in integral and differential form: for static fields, for time varying fields, for free space, for good conductors, for harmonically varying fields, Poynting theorem: Energy stored and radiated power, Complex poynting vector, Properties of conductor and dielectrics, Wave equations for free space, Wave equations for conductors.

Module-5

Uniform Plane Waves: Introduction, Uniform plane wave propagation: Wave equations, Transverse nature of uniform plane waves, Perpendicular relation between E and H, EM waves in charge free, Current free dielectric, Reflection by ideal conductor: Normal incidence, reflection and transmission with normal incidence at another dielectric, Plane wave in lossy dielectric, Wave impedance and propagation constant, Depth of penetration, Surface impedance and surface resistance, Application of

EM propagation through Transmission Lines and Rectangular Waveguides

Course outcome (Course Skill Set)

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

- Appraise need analysis for different coordinate systems in electromagnetics and their interrelations.
- Apply vector calculus to solve field theory problems.
- Calculate electric and magnetic fields in different coordinates for various charge and current configurations.
- Exhibit the concept of time varying fields and demonstrate different aspects of plane wave in dielectric and conducting media.
- Realize the analogy of wave with transmission line and determine the transmission line performance.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Thetheory portionof theIPCCshallbefor bothCIEandSEE,whereasthepracticalportionwillhaveaCIE component only. Questions mentioned in the SEE paper shall include questions from the practicalcomponent).

- 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. Thelaboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from thelaboratorycomponentshallbeincluded.Themaximumof04/05questionstobesetfromthepracti

cal componentofIPCC,thetotalmarksof allquestionsshouldnot bemorethanthe20marks.

- SEEwillbeconductedfor100marksandstudentsshallsecure40%ofthemaximummarkstoqualifyinthe SEE.Markssecuredwillbescaleddownto50.(Studenthastosecureanaggregateof50%of maximummarksof thecourse(CIE+SEE)

Suggested Learning Resources:

Textbooks:

- Kraus, J.D., Electromagnetics, McGrawHill (2006).
- Sadiku, M.N.O, Elements of Electromagnetics, Oxford University Press (2009).

ReferenceBooks:

- Hayt, W.H., Engineering Electromagnetics, Tata McGraw Hill (2008).
- Jordan, E.C. and Balmain K.G., Electromagnetic Waves and Radiating Systems, Prentice Hall of India (2008).

Paramanik, A, Electromagnetism: Theory and Applications, Prentice Hall of India (2006)

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=yzgGHAoN_68&list=PLyqSpQzTE6M_OXWtn1RUnuZNSbSSy6Lys
https://www.youtube.com/watch?v=rveuCHNkaC4&list=PLyqSpQzTE6M_OXWtn1RUnuZNSbSSy6Lys&index=10
https://www.youtube.com/watch?v=C9m2NJ03eGk&list=PLyqSpQzTE6M_OXWtn1RUnuZNSbSSy6Lys&index=26

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

- Project related to Antenna and Microwave with Electromagnetic Application

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	1	-	-	1
CO2	3	3	3	2	1	1	-	-	1	-	-	1
CO3	3	3	3	2	1	1	-	-	1	-	-	1
CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

ADVANCEDCOMMUNICATION NETWORKS		Semester	1
Course Code	**22LAC15**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

Thiscoursewillenablestudents:

- To know the networking concepts.
- To study the networking protocols.
- To have an in-depth knowledge of congestion control and resource allocation
- To have knowledge on security.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

Module-1

Foundation:BuildingaNetwork,Applications,Requirements,NetworkArchitecture, Implementing Network Software, Performance

Module-2

Advanced Internetworking: The Global Internet, Multicast, Multicast addresses, Multicast, Multiprotocol Label Switching (MPLS)

End-to-End protocols: Simple Demultiplexer (UDP), Reliable Byte Stream (TCP)

Module-3

CongestionControlandResourceAllocation:AllocatingResources,IssuesinResourceallocation,QueuingDisciplines,TCPCongestionControl,Congestion-Avoidance Mechanisms, Quality of Service

Module-4

Applications: Traditional Applications: Electronic Mail (SMTP, POP, IMAP,MIME), World Wide Web (HTTP), Multimedia Applications, InfrastructureServices(DomainNameSystem(DNS),NetworkManagement(SNMP),OverlayNetworks

Module-5

End-to End data: Presentation formatting, Multimedia Data Network Security:Securityattacks,Cryptographicbuildingblocks,KeyPredistribution,Authenticationprotocols,Firewalls

Course outcome (Course Skill Set)

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

- Classify network services, protocols and architectures, explain why they are layered.
- Knowledge on Advanced Internetworking applications and their protocols, and ability to work on their own applications (e.g. Client Server applications, Web Services).
- To analyse various techniques for Congestion avoidance and Resource Allocation.
- Gain the knowledge of application layer protocols.
- Understand the concept of Network Security through cryptographic blocks, authentication protocols and Firewalls.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. TheSEE question paper willbesetfor100 marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module.

Suggested Learning Resources:

Textbooks:

1. 'ComputerNetworks:ASystemApproach',LarryPetersonandBruceSDavis, 5th Edition,Elsevier-2014.
2. 'InternetworkingwithTCP/IP,Principles,ProtocolsandArchitecture',DouglasEComer,6th Edition,PHI–2014

ReferenceBooks:

1. 'Computer Networks, Protocols, Standards and Interfaces',UylessBlack,2nd Edition, PHI.
2. 'TCP /IP Protocol Suite', Behrouz A Forouzan, 4th Edition, Tata McGraw-Hill

Web links and Video Lectures (e-Resources):

- http://www.embeddedtechnology.com/
- https://www.edx.org/learn/embedded-systems
- http://www.realtime-info.be/magazine/98q4/1998q4_p014.pdf

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

- Showing example of each layer

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
CO1	3	3	3	1	1	1	-	-	1	-	-	1
CO2	3	3	3	1	1	1	-	-	1	-	-	1
CO3	3	3	3	1	1	1	-	-	1	-	-	1
CO4	3	3	3	1	1	1	-	-	1	-	-	1
CO5	3	3	3	1	1	1	-	-	1	-	-	1

RESEARCH METHODOLOGY & IPR		Semester	1
Course Code	**22RM16**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

Thiscoursewillenablestudents:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

ResearchMethodology: Introduction,MeaningofResearch,ObjectivesofResearch, Motivation in Research, Types of Research, Research Approaches,SignificanceofResearch,ResearchMethodsversusMethodology,ResearchandScientificMethod,ImportanceofKnowingHowResearchisDone,Research Process, Criteria of Good Research, and Problems Encountered byResearchersinIndia.

Defining the Research Problem: Research Problem, Selecting the Problem,Necessity of Defining the Problem, Technique Involved in Defining a Problem,AnIllustration.

Module-2

Reviewing the literature: Place of the literature review in research, Bringingclarity and focus to your research problem, Improving research methodology,Broadening knowledge basein research area, Enabling contextual findings,How to review the literature, searching the existing literature, reviewing theselectedliterature,Developingatheoreticalframework,Developingaconceptualframework, Writingaboutheliteraturereviewed.

Research Design: Meaning of Research Design, Need for Research Design,Features of a Good Design, Important Concepts Relating to Research Design,DifferentResearchDesigns,BasicPrinciplesofExperimentalDesigns,ImportantExperimental Designs.

Module-3

DesignofSampling: Introduction,SampleDesign,SamplingandNon-sampling Errors, Sample Survey versus Census Survey, Types of SamplingDesigns.

Measurement and Scaling: Qualitative and Quantitative Data, Classificationsof Measurement Scales, Goodness of Measurement Scales, Sources of Error inMeasurementTools,Scaling,ScaleClassificationBases,ScalingTechnics,MultidimensionalScaling,Decidingth e Scale.

DataCollection:ExperimentalandSurveys,CollectionofPrimaryData,CollectionofSecondaryData,Selectionof AppropriateMethodforDataCollection, Case StudyMethod.

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing ofHypotheses, Testing of Hypothesis, Test Statistics and Critical Region, CriticalValueandDecisionRule,ProcedureforHypothesisTesting,HypothesisTesting for Mean, Proportion, Variance,for Difference of Two Mean, forDifferenceofTwoProportions,forDifferenceofTwoVariances,P-Valueapproach,Power ofTest, LimitationsoftheTestsofHypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test ofIndependence of Attributes, Test of Goodness of Fit, Cautions in Using ChiSquareTests.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique ofInterpretation,PrecautioninInterpretation,SignificanceofReportWriting,Different Steps in Writing Report, Layout of the Research Report, Types ofReports,OralPresentation,MechanicsofWritingaResearchReport,PrecautionsforWritingResearchReports.

Intellectual Property: TheConcept,Intellectual Property System in India,Development of TRIPS Complied Regime in India, Patents Act, 1970, TradeMarkAct,1999,TheDesignsAct,2000,TheGeographicalIndicationsofGoods(RegistrationandProtection)Act1999,CopyrightAct,1957,TheProtectionofPlantVarietiesandFarmers'RightsAct,2001,TheSemi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets,UtilityModels, IPR and Biodiversity, The Convention on Biological Diversity (CBD)1992,CompetingRationalesforProtection of IPRs,Leading InternationalInstrumentsConcerningIPR,WorldIntellectualPropertyOrganisation(WIPO),WIPO and WTO

Course outcome (Course Skill Set)

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

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. TheSEE question paper willbesetfor100 marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Suggested Learning Resources:

Text Books:

1. Research Methodology: Methods and Techniques', C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018

2.'Research Methodology a step-by-step guide for beginners., Ranjit Kumar, SAGE Publications, 3rd Edition, 2011

3. Study Material (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books:

1.'Research Methods: the concise knowledge base', Trochim, Atomic Dog Publishing, 2005

2.'Conducting Research Literature Reviews: From the Internet to Paper', Fink A, Sage Publications, 2009

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=E2gGF1rburw&list=PLyqSpQzTE6M8F_P8lgjvmqiDEoFGLzG4h
https://www.youtube.com/watch?v=mgudvPjuiU0&list=PLyqSpQzTE6M8F_P8lgjvmqiDEoFGLzG4h&index=4
https://www.youtube.com/watch?v=25yhhi2LX7Q&list=PLyqSpQzTE6M8F_P8lgjvmqiDEoFGLzG4h&index=6

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**-**	**1**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**
CO3	**3**	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**	**-**
CO4	**3**	**3**	**1**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**2**	**-**
CO5	**2**	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**2**	**2**	**2**	**2**

ADVANCED DIGITAL SIGNAL PROCESSING LABORATORY			
Course Code	**22LACL17**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Total Marks	100
Examination type (SEE)	Practical	Exam Hours	03

Course objectives: This course will enable students to:

- To know the analysis of discrete time signals.
- To study the modern digital signal processing algorithms and applications.
- To Have an in-depth knowledge of use of digital systems in real time applications
- To apply the algorithms for wide area of recent applications.

Sl. No.	**Experiments**
1	Generate various fundamental discrete time signals
2	Basic operations on signals (Multiplication, Folding, Scaling).
3	Find out the DFT & IDFT of a given sequence without using inbuilt instructions.
4	Interpolation & decimation of a given sequence.
5	Generation of DTMF (Dual Tone Multiple Frequency) signals
6	Estimate the PSD of a noisy signal using periodogram and modified periodogram
7	Estimation of PSD using different methods (Bartlett, Welch, Blackman-Tukey).
8	Design of Chebyshev Type I, II Filters.
9	Cascade Digital IIR Filter Realization.
10	Parallel Realization of IIR filter.
11	Estimation of power spectrum using parametric methods (YuleWalker&Burg).

12	Time-Frequency Analysis with the Continuous Wavelet Transform.
13	Signal Reconstruction from Continuous Wavelet Transform Coefficients.

Conduct the experiments using MATLAB/Scilab/TMS 320 C5X DSP Processors

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

1. Able to generate discrete time signals and perform DFT, IDFT on the signals.
2. Able to estimate the PSD using different methods.
3. Able to design and realize FIR and IIR filters.
4. Able to estimate power spectrum using Parametric methods.
5. Able to analyze in Time and Frequency domain and reconstruct the signal using Wavelet Transform.

SEMESTER – II

ADVANCED COMMUNICATION SYSTEMS-2			
Course Code	22LAC21	Semester	2
Teaching Hours/Week (L: T:P: S)	2:0:2	CIE Marks	50
Total Hours of Pedagogy	40	SEE Marks	50
Credits	03	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course objectives:

Thiscourse will enablestudents:

- Todescribe modelsforfadingchannels, andconceptsof diversityin time, frequencyand space.
- Tounderstandconceptsofmulti-channelsignaling(includingOFDM)schemeandsynchronizationforcarrierand symboltimingrecoveryatreceiver.
- Tounderstandperformanceinamultipathfading environmentincluding maximalratiocombining,RAKEreceivers,OFDMandMIMO.
- DevelopandevaluatetheperformanceofaOFDMMIMOschemetomeetspecifiedrateinagiven
- multipathenvironment.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

Synchronization–

SignalParameterestimation,CarrierPhaseEstimation,SymbolTimingRecovery,PerformanceofML estimators.

Fading–Largescale,smallscale;Statisticalcharacterizationofmultipathchannels–DelayandDoppler spread,classificationofmultipathchannels,scatteringfunction,Binary signalingoverfrequencynonselective Rayleig

hfadingchannel.

Module-2

Fading Contd.: - Diversity techniques for performance improvement with binary signaling over FNS, Slowfading channels – power combining and Maximal ratio combining; Frequency selective channels– Rakereceivers,Performance,Tap weightSynchronization,Applicationto CDMA.

Multicarrier Signaling: A brief overview of Frequency Diversity. Multicarrier Communications in AWGNchannel- Single carrier vs Multicarrier, OFDM, FFT Implementation, Spectral Characteristics, Power and bitallocation,Peakto AveragePowerRatio, ChannelCodingConsiderations.

Module-3

Capacityofwirelesschannel:AWGNchannelcapacity,ResourcesofAWGNchannel,LineartimeinvariantGaussianchannel, Capacityof FadingChannels.

Module-4

MIMOspatialmultiplexingandchannelmodeling:MultiplexingcapabilityofdeterministicMIMOchannels,Physical modelingof MIMO channels, Modelingof MIMO fadingchannels.

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, Receiverarchitectures – (Linear decorrelator, Successive cancellation, Linear MMSE receiver), Information theoreticoptimality,ConnectionswithCDMAmultiuser detectionandISIequalization,SlowfadingMIMOchannel.

Course outcome (Course Skill Set)

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

6. Describe models for fading channels, and concepts of diversity in time, frequency and space.
7. Explain the concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver
8. Evaluate the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.
9. Develop &analyze schemes to improve performance in a multipath fading environment including maximal ratio combining, RAKE receivers, OFDM and MIMO
10. Develop and evaluate the performance of a OFDM MIMO scheme to meet specified rate in a given multipath environment

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

Textbooks:

1. 'DigitalCommunications',JohnG.Proakis,MasoudSalehi,PearsonEducation,ISBN:978-9332535893,5thedition,2014
2. 'FundamentalsofWirelessCommunication',DavidTse,PramodViswanath,CambridgeUniversityPress,ISBN:0521845270,1stedition, 2005

ReferenceBook:

'DigitalCommunicationSystems',SimonHaykin,Wiley,ISBN:978-0471-64735-5,2014

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=nIata4K7egE
2. https://www.youtube.com/watch?v=GrLaF_EKcuk

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

- Mini project on communication model

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	-	-	-	-	-	1	-	3
CO2	3	3	1	1	3	-	-	-	-	1	-	3
CO3	3	3	1	1	3	-	-	-	-	1	-	3

CO4	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**
CO5	**3**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**3**

ANTENNA THEORY AND DESIGN			
Course Code	22LAC22	Semester	2
Teaching Hours/Week (L:T:P: S)	3:2:0	CIE Marks	50
Total Hours of Pedagogy	40 HoursTheory+ 10-12 Lab	SEE Marks	50
Credits	04	Total Marks	100
Examination nature (SEE)	Theory + Lab	Exam Hours	03

Course objectives:

Thiscoursewillenablestudents:

- Toclassifydifferent typesofantennas
- Todefineandillustratevarioustypesofarrayantennas
- TodesignantennaslikeYagi-Uda,Helical antennasandotherbroadbandantennas
- Todescribedifferentantennasynthesismethods
- ToapplymethodslikeMethodofMoments,Pocklington'sintegralequation, Sourcemodeling.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.
Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

MODULE-1

Antenna Fundamentals and Definitions: Radiation Mechanisms, Overview, EM Fundamentals, Solution ofMaxwell's Equations for Radiation Problems, Ideal Dipole, Radiation patterns, Directivity and Gain, Antennaimpedance,Radiationefficiency,Antennapolarization.

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. AntennaSynthesis: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis,Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method, Comparison

MODULE-3

ResonantAntennas: WiresandPatches,Dipoleantenna,Yagi-Udaantennas,Micro-stripantenna.**Broadbandantennas:**TravelingwaveantennasHelicalantennas,Biconicalantennas,Sleeveantennas,and Principlesoffrequencyindependentantennas, Spiralantennas, and Log -periodicantennas.

MODULE-4

Aperture antennas: Techniques for evaluating gain, Reflector antennas, Parabolic reflector antenna principles,Axi-symmetricparabolicreflectorantenna,Offsetparabolicreflectors,Dualreflectorantennas,Gaincalculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to thereflector,Generalfeedmodel,Feedantennasusedinpractice.

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 integralequation,IntegralequationandKirchhoff'snetworkingequations,Sourcemodelingweightedresidualformulations andcomputationalconsideration,Calculationofantennaandscattercharacteristics.

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

Sl.NO	Experiments
1	MATLAB/Cimplementationtoobtainthe radiationpatternofan antenna.
2	Studyof radiation pattern of differentantennas.
3	Determinethedirectivityandgains ofHorn/Yagi/dipole/Parabolicantennas.
4	ImpedancemeasurementsofHorn/Yagi/dipole/Parabolicantennas
5	Studyof radiationpattern of E&H planehorns.
6	SignificanceofPocklington'sintegralequation.
7	Determinethedirectivityandgainsofdipoleantennas.
8	ImpedancemeasurementsofYagi antennas.
9	DeterminethedirectivityandgainsofParabolicantennas.
10	StudyofradiationpatternofEplanehorns

Course outcomes (Course Skill Set):

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

- 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 modelling

AssessmentDetails(bothCIE andSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

CIEforthe theorycomponent of IPCC

7. TwoTests each of **20 Marks**
8. Twoassignmentseachof **10Marks/OneSkillDevelopmentActivityof20marks**

9. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60marks,marks scored willbeproportionallyscaled down to**30marks**.

CIEforthe practical component ofIPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated andmarks shall be awarded on the same day.The **15 marks** are for conducting the experiment andpreparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end ofthesemester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuousevaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of allexperiments'write-ups areaddedand scaled downto 15marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marksandscaled downto 05 marks**.**

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

SEEfor IPCC

TheorySEEwill beconductedbyUniversityasperthescheduled timetable,withcommon questionpapersforthecourse (duration 03Hours)

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50marks.

7. Thequestionpaper will havetenquestions.Eachquestionisset for20marks.
8. Therewillbe2questionsfromeachmodule.Eachofthetwoquestionsunderamodule(withamaximumof3 sub-questions),**shouldhave amixoftopics**under thatmodule.
9. Thestudents have toanswer 5 fullquestions,selectingonefullquestion fromeachmodule.

Thetheory portionof theIPCCshallbefor bothCIEandSEE,whereasthepracticalportionwillhaveaCIE component only. Questions mentioned in the SEE paper shall include questions from the practicalcomponent).

- 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. Thelaboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from thelaboratorycomponentshallbeincluded**.**Themaximumof04/05questionstobesetfromthepractical componentofIPCC,thetotalmarksof allquestionsshouldnot bemorethanthe20marks.
- SEEwillbeconductedfor100marksandstudentsshallsecure40%ofthemaximummarkstoqualifyintheSEE.Markssecuredwillbescaleddownto50.(Studenthastosecureanaggregateof50%of maximummarksof thecourse(CIE+SEE)

Suggested Learning Resources:

Textbook:

'AntennaTheoryandDesign', StutzmanandThiele,John Wiley,2ndEdition,2010

ReferenceBooks:

3. 'AntennaTheoryAnalysis andDesign', C.A. Balanis, JohnWiley, 2ndEdition,2007
4. 'AntennasandWavePropagation',J.D. Krauss,McGraw Hill TMH,4thEdition, 2010
5. 'Antennasandpropagation',A.R.Harish,M.Sachidanada,PearsonEducation,2015

WeblinksandVideoLectures(e-Resources):

1. https://www.youtube.com/watch?v=axUcybeamIk
2. https://www.youtube.com/watch?v=sKYpHt0p7HQ

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

MiniProject inthe area ofAntenna design usingmodern tools likeCST, HFSS

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1	-	-	-	-	-	-	-	2
CO2	3	3	3	-	3	-	-	-	-	-	-	2
CO3	1		2	-	3	-	-	-	-	-	-	2
CO4	1			1	-	-	-	-	-	-	-	1
CO5	1			-	2	-	-	-	-	-	-	1

ADVANCED COMMUNICATION LABORATORY			
CourseCode	22LACL26	CIEMarks	50
TeachingHours/Week(L:T:P:S)	1:2:0	SEE Marks	50
Credits	02	Total Marks	100
		Exam Hours	03

Course objectives: This course will enable students to:

- Understandandplot theradiationpatternofspecifiedantennasusingMATLABandwaveguidesetup.
- Determinecharacteristicsofagivenantenna.
- ComputetheS-parametersofMagicteeanddirectional couplers.
- TesttheICCD4051formodulationtechniques.
- 5.UnderstandthemultiplexingtechniquesusingOFCkit.

Sl.No.	Experiments
1	MATLAB/Cimplementation toobtaintheradiationpatternofanantenna.
2	Studyof radiationpatternofdifferent antennas.
3	DeterminethedirectivityandgainsofHorn/Yagi/dipole/Parabolicantennas.
4	ImpedancemeasurementsofHorn/Yagi/dipole/Parabolicantennas.
5	Studyofradiationpatternof E&Hplanehorns.
6	SignificanceofPocklington'sintegralequation.
7	Studyof digital modulationtechniquesusingCD4051IC.
8	ConductanexperimentforVoiceanddatamultiplexingusingOptical fiber.

	Demonstration Experiments (For CIE) if any
9	Determinationofthemodestransittime, electronictimingrange andsensitivityofKlystronsource.
10	DeterminationofVIcharacteristicsofGUNNdiode,andmeasurementofguidewavelength, frequencyandVSWR.
11	Determinationofcouplingcoefficientandinsertionlossofdirectionalcouplersand Magictee.
12	Buildahardwarepseudo-randomsignalsourceanddeterminestatisticsofthegeneratedsignalsource.

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

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

1. Plottheradiationpatternofspecified antennasusingMATLABandwave guidesetup.
2. Determinegainanddirectivityofagiven antenna.
3. ObtaintheS-parametersofMagicteeanddirectionalcouplers.
4. TesttheICCD4051formodulationtechniques.
5. ComprehendthemultiplexingtechniquesusingOFCkit.

AssessmentDetails(bothCIEandSEE)

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 havesatisfied the academic requirements and earned the credits allotted to each course. The student has to securenot less than 40%of maximum marks in the semester-end examination (SEE). In total of CIE andSEEstudent hasto secure 50%maximummarks ofthe course.

ContinuousInternal Evaluation(CIE):

CIE marks forthepracticalcourseis**50Marks**.

Thesplit-upofCIE marks forrecord/journalandtest areintheratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics forthe evaluation of the journal/write-up for hardware/software experiments designed by the faculty who ishandlingthelaboratorysessionandismadeknowntostudentsatthebeginningofthepractical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will beevaluatedfor10 marks.
- Totalmarks scoredbythestudentsarescaleddownedto30marks(60%ofmaximummarks).
- Weightagetobegivenforneatnessandsubmissionofrecord/write-upontime.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of thesemesterandthesecond testshallbeconductedafterthe14thweekofthe semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge willcarrya weightage of60%and therest40%for viva-voce.
- Thesuitablerubricscanbedesignedtoevaluateeachstudent'sperformanceandlearningability.
- Theaverageof02testsisscaled downto**20marks** (40% ofthemaximummarks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the totalCIE marks scored bythe student.

SemesterEndEvaluation(SEE):

SEEmarksforthepracticalcourseis50Marks.

SEEshallbeconductedjointlybythetwoexaminersofthesameinstitute,examinersareappointedbytheUniversity.

- All laboratoryexperimentsaretobeincludedforpracticalexamination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to bestrictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall bedecidedjointlybyexaminers.
- Students can pick one question (experiment) from the questions lot prepared by the internal /externalexaminersjointly.
- Evaluationoftest write-up/conductionprocedureandresult/viva willbeconductedjointlybyexaminers.
- General rubricssuggested forSEE arementionedhere,writeup-20%,Conductionprocedureandresultin -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scoredmarks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by theexaminers)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be madezero.

Theduration ofSEE is 03hours

WeblinksandVideoLectures(e-Resources): **1** **https://www.youtube.com/watch?v=axUcybeamIk** **2** **https://www.youtube.com/watch?v=sKYpHt0p7HQ**
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning **MiniProject inthe area ofAntenna design usingmodern tools likeCST, HFSS**

WIRELESSSENSORNETWORKS		Semester	2
Course Code	22LAC231	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	(2:0:2)	SEE Marks	50
Total Hours of Pedagogy	30HoursTheory+10 HoursSDA	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

CourseLearningobjectives: Thiscoursewillenablestudentsto:

- LearnthebasicconceptsofWirelesssensornetworksarchitectureandprotocols.
- UnderstandthechallengesindesigningaWirelesssensornetworks.
- UnderstandthefunctionofDatalinkandNetworklayerProtocols.
- UnderstandthefunctionofTransport layerProtocols.
- Analyzewirelesssensornetworksystemfordifferentapplicationsunderconsideration

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

INTRODUCTION: SensorMotePlatforms,WSNArchitectureandProtocolStack ,WSNApplications:MilitaryApplications,EnvironmentalApplications,HealthApplications,Home Applications,IndustrialApplications.

Module-2

FACTORS INFLUENCING WSN DESIGN: Hardware Constraints Fault Tolerance Scalability ProductionCosts WSN Topology, Transmission Media, Power Consumption (Chap. 3 Text 1). Physical Layer:

PhysicalLayerTechnologies,OverviewofRFWirelessCommunication,ChannelCoding(ErrorControlCoding), Modulation,WirelessChannel Effects,PHYLayer Standards.

Module-3

MEDIUM ACCESS CONTROL: Challenges for MAC, CSMA Mechanism, Contention-Based MediumAccess, Reservation-Based Medium Access, Hybrid Medium Access (Chap. 5 of Text 1). Network Layer:ChallengesforRouting,Data-centricandFlatArchitectureProtocols,HierarchicalProtocols,Geographical RoutingProtocols.

Module-4

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

ApplicationLayer: SourceCoding(DataCompression),QueryProcessing,NetworkManagement(Chap.9 Text 1).

Module-5

SPREADSPECTRUMSIGNALSFORDIGITALCOMMUNICATION:Modelofspreadspectrumdigital communication system, Direct sequence spread spectrum signals, some applications of DS spreadspectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS,Synchronizationof SSsystems.

Course outcome (Course Skill Set)

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

1. Acquire knowledge of characteristics of mobile/wireless communication channels
2. Apply statistical models of multipath fading
3. Understand the multiple radio access techniques, radio standards and communication protocols to be used for wireless sensor
4. Design wireless sensor network system for different applications under consideration.
5. Understand the hardware details of different types of sensors and select right type of sensor for various applications.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. Three UnitTestseachof **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs andPOs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwill beproportionatelyreduced to50.
2. Thequestionpaperwillhavetenfullquestionscarryingequal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions)fromeach module.
4. Eachfull questionwill haveasub-questioncoveringallthetopicsunderamodule.

Thestudentswill havetoanswerfivefull questions,selectingonefull questionfromeachmodule

Suggested Learning Resources:

Textbook:

1. WirelessSensorNetworks,IanF.AkyildizandMehmetCanVuran,JohnWiley&SonsLtd.ISBN978-0-470-3601-3(H/B),2010
2. WirelessSensorNetworks:SignalProcessingandCommunicationsPerspectives',AnanthramSwami,et.al, JohnWiley&Sons Ltd.,ISBN978-0470-03557-3, 2007.

Web links and Video Lectures (e-Resources):

MassiveOpenOnlineCourses:

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

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

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare aresearchArticle.
- ImplementNetworkingconceptsusingNS2/NS3/OMNET/OPNET/QUALNETsoftwaretool.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	2	-	-	1
CO2	3	3	3	2	2	1	-	-	2	-	-	1
CO3	3	3	3	3	3	1	-	-	2	-	-	1
CO4	3	3	3	3	3	1	1	-	2	-	-	1
CO5	3	3	3	3	2	2	2	-	2	-	-	1

Course Code	22LAC232	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	(2:0:2)	SEE Marks	50
Total Hours of Pedagogy	30HoursTheory+10 HoursSDA	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

Thiscoursewill enablestudentsto:

- KnowtheprinciplesbehindNanoscienceengineeringandNanoelectronics.
- Applytheknowledgetoprepareandcharacterizenanomaterials.
- Knowtheeffectofparticlessizeonmechanical,thermal,opticalandelectrical propertiesofnanomaterials.
- Designtheprocessflowrequiredtofabricatestateofthearttransistortechnology.
- Analyzetherequirementsfornewmaterialsanddevicestructureinthefuturetechnologies.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

Module-1

Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication andelectronic industry. Moores' law and continued miniaturization, Classification of Nanostructures, Electronicproperties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electronmodels and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects ofnanometerlengthscale,Fabricationmethods:Topdownprocesses,Bottomupprocessesmethodsfortemplatingthegrowthofnanomaterials,orderingofnano systems.

Module-2

Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques,diffractiontechniques:bulkandsurfacediffractiontechniques,spectroscopytechniques:photon,radiofrequency,electron,surfaceanalysisanddeptprofiling:electron,mass,Ionbeam,Reflectometry,Techniquesfor propertymeasurement:mechanical,electron, magnetic,thermalproperties.

Module-3

Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement insemiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, andelectronicdensityof states.

CarbonNanostructures: Carbonmolecules,CarbonClusters,CarbonNanotubes,applicationofCarbon Nanotubes.

Module-4

Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithographyandetching,cleaved-edgeovergrowth,growthofvicinalsubstrates,straininduceddotsandwires,electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells,semiconductornanocrystals, colloidalquantumdots, self-assemblytechniques.

Physical processes: modulation doping, quantum hall effect, resonant tunnelling, charging effects, ballisticcarrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck,quantumconfinedstarkeffect,nonlineareffects,coherenceanddephasing,characterizationofsemiconductor nanostructures:opticalelectricalandstructural(Text1).

Module-5

Methodsofmeasuringproperties:atomic,crystallography,microscopy,spectroscopy

Applications: Injectionlasers,quantumcascadelasers,single-photonsources,biologicaltagging,opticalmemories,coulombblockadedevices,photonicstructures,QWIPs,NEMS,MEMS.

Course outcome (Course Skill Set)

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

- Know the principles behind Nanoscience engineering and Nanoelectronics.
- Apply the knowledge to prepare and characterize nanomaterials.
- Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials
- Designtheprocessflowrequiredtofabricatestateofthearttransistor technology
- Analyzetherequirementsfornewmaterialsanddevicestructureinthefuture technologies.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain theCOs andPOs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequalmarks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-

questions)fromeach module.

4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Suggested Learning Resources:

SuggestedLearningResources:

Textbooks:

1. 'NanoscaleScienceandTechnology',EdRobertKelsall,IanHamley,MarkGeoghegan,JohnWiley,2007
2. 'IntroductiontoNanotechnology',CharlesPPoole,Jr,FrankJOwens,JohnWiley,Copyright2006,Reprint 2011.

ReferenceBook:

1.'HandBookofNanoscienceEngineeringandTechnology',EdWilliamAGoddardIII,DonaldWBrenner,SergeyE. Lyshevski, Gerald JIafrate,CRCpress, 2003

Web links and Video Lectures (e-Resources):

WeblinksandVideoLectures(e-Resources):

- https://www.digimat.in/nptel/courses/video/117108047/L01.html
- https://archive.nptel.ac.in/courses/117/108/117108047/

SkillDevelopmentActivitiesSuggested

- Seminaronrecent applicationsof Carbonnanotubes

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	1	-	-	1
CO2	3	3	3	2	1	1	-	-	1	-	-	1
CO3	3	3	3	2	1	1	-	-	1	-	-	1
CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

CRYPTOGRAPHYANDNETWORKSECURITY

Course Code	22LAC233	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	(2:0:2)	SEE Marks	50
Total Hours of Pedagogy	30HoursTheory+10 HoursSDA	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

Thiscoursewillenablestudentsto:

- Understandthebasicsofsymmetrickey.
- Usebasiccryptographicalgorithmstoencrypt thedata.
- Generatesomepseudorandomnumbersrequiredforcryptographicapplications.
- Provideauthenticationandprotectionforencrypteddata.
- Understandthetechniquesandfeaturesof Email,IPandWebsecurity.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

Foundations:Terminology,Steganography,substitutionciphersandtranspositionsciphers,SimpleXOR,One-TimePads, ComputerAlgorithms

SYMMETRICCIPHERS:TraditionalBlockCipherstructure,DataEncryptionStandard(DES),TheAES Structure,AESKeyExpansion.

Module-2

MoreNumberTheory: PrimeNumbers,Fermat'sandEuler'stheorem,TestingforPrimality,TheChineseRemainder theorem, Discrete Logarithms.

PrinciplesofPublic-KeyCryptosystems,TheRSAalgorithm,Diffie-HellmanKeyExchange,EllipticCurveArithmetic,Elliptic Curve Cryptography.

Module-3

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

Module-4

One-WayHashFunctions:Background,Snefru,N-Hash,MD4,MD5,SecureHashAlgorithm[SHA],Oneway hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hashfunctions,Message Authentication Codes.

DigitalSignatureAlgorithm,DiscreteLogarithmSignatureScheme.

Module-5

E-mailSecurity:PrettyGoodPrivacy-S/MIME.

IP Security: IPSecurityOverview,IPSecurityPolicy,EncapsulationSecurityPayload(ESP).

WebSecurity:WebSecurityConsiderations, SSL.

Course outcome (Course Skill Set)

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

- Understandthebasicsofsymmetrickey.
- Usebasiccryptographicalgorithmstoencrypt thedata.
- Generatesomepseudorandomnumbersrequiredforcryptographicapplications.
- Provideauthenticationandprotectionforencrypteddata.
- Understandthetechniquesandfeaturesof Email,IPandWebsecurity.

AssessmentDetails(bothCIEandSEE)

TheweightageofContinuousInternalEvaluation(CIE)is50%andforSemesterEndExam(SEE)is50%.The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is40% of the maximum marks of SEE.A student shall be deemed to have satisfied the academic requirementsand earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) takentogether.

ContinuousInternalEvaluation:

1. Three UnitTestseachof **20 Marks**

2. Twoassignmentseachof **20Marks** or**oneSkillDevelopmentActivityof40marks** toattainthe COsand POs

Thesumofthreetests, twoassignments/skillDevelopment Activities,willbescaleddownto 50marks.

CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefinedfor the course.

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfive fullquestions,selectingone fullquestion fromeachmodule

Suggested Learning Resources:

Textbooks:

1. "CryptographyandNetworkSecurityPrinciplesandPractice",WilliamStallings,PearsonEducationInc.,ISBN: 978-93325-1877-3,6th Edition, 2015
2. "AppliedCryptographyProtocols,Algorithms,andSourcecodeinC",BruceSchneier,WileyPublicationsISBN: 9971-51348-X, 2ndEdition

ReferenceBooks:

1. "Cryptographyand NetworkSecurity", BehrouzA. Forouzan,TMH,2007

"CryptographyandNetworkSecurity",AtulKahate,TMH, 200

WeblinksandVideoLectures(e-Resources):

https://nptel.ac.in/courses/106105162

Cryptography&NetworkSecurity, IIT Kharagpur, Prof.SouravMukophadhyay

SkillDevelopmentActivitiesSuggested

Onlinecertificationcourseonprobabilityandrandomprocess.

Miniprojectscanbe suggestedontherelatedarea.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

OPTICALCOMMUNICATIONANDNETWORKING			
CourseCode	22LAC234	CIEMarks	50
TeachingHours/Week(L:P:SDA)	(2:0:2)	SEEMarks	50
TotalHours ofPedagogy	30HoursTheory+10 HoursSDA	TotalMarks	100
Credits	03	ExamHours	3

CourseLearningobjectives: Thiscoursewillenablestudentsto:

- Understandthevariousopticaldevicesandhowtheyoperate.
- Recognizeandchoosevariouscomponentsforopticalnetworkinginaccordancewiththeestablisheddesignrequirements
- Acquireknowledgeoftheelementsofdatatransmission,lossobstacles,andothernetworkoperatingartifacts.
- Acquireknowledgeoftheproblemsassociatedwithsettingupandmaintainingtheopticalnetwork'saccess componentwhilekeepingupwithcurrentdatatransmissiontrends.
- BuildaWDMnetworkandexplorethemanagementofcomponentsandnetworks.

Module-1

Introductiontoopticalnetworks: OpticalNetworks,opticalpacketswitching,Propagationofsignalsin opticalfiber:Differentlosses,Nonlineareffects,Solitons.OpticalComponents(Part-1):Couplers,Isolators,andCirculators. **RBTLevel: L1,L2**

Module-2

OpticalComponents(Part-2): MultiplexersandFilters,OpticalAmplifiers,detectors.Modulation-Demodulation: Formats, Ideal receivers, Practical direct detection receivers, Optical preamplifiers, Bit errorrates,Coherent detection. **RBTLevel: L1, L2**

Module-3

Transmission System Engineering: System model, Power penalty, Transmitter, Receiver, Crosstalk. ClientLayers of optical layer: SONET/SDH: Multiplexing, layers, Frame structure. Asynchronous Transfer Mode:ATMfunctions, Adaptationlayers, Qualityof Service(QoS) andflowcontrol, Signalingand Routing.

RBTLevel:L1,L2

Module-4

WDM network elements: Optical line terminals, Optical line amplifiers, Optical Add/ Drop Multiplexers,Optical cross-connects. WDM Network Design: Cost trade-offs, LTD and RWA problems, Routing andwavelengthassignment, Wavelength conversion.

RBTLevel:L1,L2

Module-5

Control and Management (Part-1): Network management functions, management framework, Informationmodel,managementprotocols,Layerswithintheopticallayer.37ControlandManagement(Part-2):Performanceandfaultmanagement,Impactoftransparency,BERmeasurement,Opticaltrace,Alarm management,Configurationmanagement,OpticalSafety. **RBTLevel: L1,L2,L3,L4**

AssessmentDetails(bothCIEandSEE)

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 is40%ofthemaximummarksofSEE.Astudentshallbedeemedtohavesatisfiedtheacademicrequirements and earned the credits allotted to each subject/ course if the student secures not less than50%(50marksoutof100)inthesumtotaloftheCIE(ContinuousInternalEvaluation)andSEE(SemesterEndExamination)takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseachof **20Marks**
2. Twoassignmentseachof**20Marks**or**oneSkillDevelopmentActivityof40marks** toattaintheCOs andPOs

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 pertheoutcome definedforthe course.**

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwillhavetenfullquestionscarryingequalmarks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)from eachmodule.
4. Eachfullquestionwillhaveasub-questioncoveringallthetopicsunderamodule.
5. Thestudentswillhavetoanswerfive fullquestions,selectingonefullquestionfromeachmodule

SuggestedLearningResources:

Textbooks:1.''OpticalNetworks',RajivRamaswami,KumarN.SivarajanandGalanHSasaki,MorganKaufmanPublishers, 3rd edition, 2010.

ReferenceBooks:

1. 'Opticalfibercommunication',JohnM.Senior,Pearsonedition, 2000.
2. 'OpticalfiberCommunication',GerdKeiser,JohnWiley,NewYork,5thEdition,2017.
3. 'FiberOpticNetworks',P.E.Green,PrenticeHall,1994.

WeblinksandVideoLectures(e-Resources):

https://onlinecourses.nptel.ac.in/noc20_ph07/preview

https://www.classcentral.com/course/swayam-optical-communications-6699

SkillDevelopmentActivitiesSuggested

- MiniProjectscanbesuggestedtoimprovetheprogrammingskills.
- Onlinecertificationcoursescan besuggestedin therelatedarea.

Courseoutcome(CourseSkillSet)

Attheendofthecoursethe studentwillbeableto:

- Comprehend the various optical devices and their working strategies
- Recognize and select various optical networking components according to the prescribed design

specifications

- Learn the aspects of data transmission, loss hindrances, and other artifacts affecting the network operation
- Learn the issues involved in setting up and maintaining access part of the optical network with the latest trends in the data communication
- Design a WDM network and study the component and network management aspects

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	-	-	1	-	-	1
CO2	3	3	3	1	1	1	-	-	1	-	-	1
CO3	3	3	3	1	1	1	-	-	1	-	-	1
CO4	3	3	3	1	1	1	-	-	1	-	-	1
CO5	3	3	3	1	1	1	-	-	1	-	-	1

BIOMEDICALSIGNALPROCESSING

CourseCode	22LAC235	CIEMarks	50
TeachingHours/Week(L:P: SDA)	2:0:2	SEE Marks	50
TotalHoursofPedagogy	30HoursTheory+ 10 Hours SDA	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

- Modelabiomedical system.
- Understandvariousmethodsof acquiringbiosignals.
- Understandvarioussourcesofbiosignaldistortionsanditsremedialtechniques.
- AnalyzeECGandEEGsignalwithcharacteristicfeaturepoints.
- Understanduseofbiosignalsin diagnosis,patient monitoringandphysiologicalinvestigation.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

MODULE-1

Introduction-

Genesisandsignificanceofbioelectricpotentials,ECG,EEG,EMGandtheirmonitoringandmeasurement,Spectralanalysis

.

RBTLevel: L1,L2

MODULE-2

Filtering-Digital andAnalogfiltering,CorrelationandEstimationtechniques,AR/ARMAmodels.

RBTLevel: L1,L2

MODULE-3

ECG-Pre-processing,Measurementsofamplitudeandtimeintervals,Classification,QRSdetection,STsegmentanalysis,Baseline wanderremoval,waveformrecognition,morphologicalstudiesandrhythmanalysis,automated diagnosisbasedondecisiontheoryECT compression,Evokedpotentialestimation.

RBTLevel: L2,L3

MODULE4

EEG:Evokedresponses,Epilepsydetection,Spikedetection,Hjorthparameters,averagingtechniques,removal of Artifacts by averaging and adaptive algorithms, pattern recognition of alpha, beta, theta and deltawavesin EEGwaves, sleepstages.

RBTLevel: L2,L3

MODULE5

EMG-Wavepatternstudies,biofeedback,Zerocrossings,IntegratedEMG.TimefrequencymethodsandWaveletsin BiomedicalSignalProcessing.

RBTLevel:L2,L3

AssessmentDetails(bothCIEandSEE)

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ContinuousInternalEvaluation:

- ThreeUnitTestseach of**20Marks.**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

- TheSEE questionpaperwillbesetfor100marks andthemarksscoredwill beproportionatelyreducedto50.
- Thequestionpaperwill havetenfull questionscarryingequal marks.
- Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
- Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Textbook:'BiomedicalDigitalSignalProcessing',WillisJTompkins, PrenticeHallofIndia,1996.

ReferenceBooks:

. 'BiomedicalSignalProcessing(inIVparts)',R EChallisandRIKitney,MedicalandBiologicalEngg.Andcurrentcomputing, 1990-91.

2. Specialissueon'BiologicalSignal Processing',Proc.IEEE1972.

3. 'BiomedicalSignal Processing',ArnonCohen,VolumesI&II,CRCPress.

WeblinksandVideoLectures(e-Resources):

3. https://www.youtube.com/watch?v=axUcybeamIk
4. https://www.youtube.com/watch?v=sKYpHt0p7HQ

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

MiniProject inthe area ofAntenna design usingmodern tools likeCST, HFSS

Courseoutcome(CourseSkill Set) Attheendofthecoursethe student willbeableto:

- Describe models for 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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	-	-	1	-	-	1
CO2	3	3	3	1	1	1	-	-	1	-	-	1
CO3	3	3	3	1	1	1	-	-	1	-	-	1
CO4	3	3	3	1	1	1	-	-	1	-	-	1
CO5	3	3	3	1	1	1	-	-	1	-	-	1

MULTIMEDIA OVER COMMUNICATION LINKS			
Course Code	22LAC241	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	(2:0:2)	SEE Marks	50
Total Hours of Pedagogy	30HoursTheory+10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	3

CourseLearningobjectives: Thiscoursewill enablestudentsto:

- Gainfundamentalknowledgeinunderstanding thebasicsofdifferentmultimedianetworks,applications,mediatypes like textandimage.
- Analyze mediatypeslikeaudioandvideoandgainknowledgeonmultimediasystems.
- AnalyzeAudiocompressiontechniquesrequiredtocompressAudio.
- Analyzecompressiontechniquesrequiredtocompressvideo.
- GainfundamentalknowledgeabouttheMultimediaCommunicationsindifferentNetworks.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1
MultimediaCommunications: Introduction,Multimediainformationrepresentation,multimedianetworks,multimediaapplications, Applicationandnetworkingterminology.
Module-2
InformationRepresentation: Introduction,Text,Images,AudioandVideo. **Distributedmultimediasystems:**Introduction,mainFeaturesofaDMS,ResourcemanagementofDMS,Networking,andMultimediaOperatingSystems.
Module-3
MultimediaProcessinginCommunication:Introduction,PerceptualcodingofdigitalAudiosignals,TransformAudio Coders,Audio Sub band Coders.
Module-4
MultimediaCommunicationStandards: Introduction,MPEGapproachtomultimediastandardization,MPEG-1,MPEG-2, Overview of MPEG-4.
Module-5
MultimediaCommunicationAcrossNetworks: Packetaudio/videointhenetworkenvironment,Videotransportacrossgenericnetworks,MultimediaTransportacrossATMNetworks.

AssessmentDetails(bothCIEandSEE)

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ContinuousInternalEvaluation:

1. Three UnitTestseachof **20 Marks**
2. Twoassignmentseachof **20Marks** or**oneSkillDevelopmentActivityof40marks**

toattainthe COsand POs

Thesumofthreetests,twoassignments/skillDevelopmentActivities,will bescaleddownto50marks.

CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefinedfor the course.

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwillhavetenfullquestionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwill haveasub-questioncoveringallthetopicsunderamodule.
5. Thestudentswill havetoanswerfivefull questions,selectingonefull questionfromeachmodule

SuggestedLearningResources:

Textbooks:

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

ReferenceBooks:

1.Raifsteinmetz,KlaraNahrstedt,"Multimedia:Computing,CommunicationsandApplications",Pearsoned ucation, 2002, ISBN-9788177584417.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	-	-	1	-	-	1
CO2	3	3	3	1	1	1	-	-	1	-	-	1
CO3	3	3	3	1	1	1	-	-	1	-	-	1
CO4	3	3	3	1	1	1	-	-	1	-	-	1
CO5	3	3	3	1	1	1	-	-	1	-	-	1

STATISTICAL SIGNAL PROCESSING			
CourseCode	22LAC242	CIEMarks	50
TeachingHours/Week(L:P:SDA)	2:0:2	SEE Marks	50
TotalHoursofPedagogy	30HoursTheory+10 HoursSDA	TotalMarks	100
Credits	03	ExamHours	3

CourseLearningobjectives: Thiscoursewillenablestudentsto

- Understand random processes and its properties
- Understand the basic theory of signal detection and estimation
- Identifytheengineeringproblemsthatcanbeputintotheframeofstatisticalsignal processing
- Solvetheidentifiedproblemsusingthestandardtechniqueslearnedthroughthiscourse.
- Makecontributionstothetheoryandthepracticeofstatisticalsignalprocessing.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

Module-1

Random Processes: Random variables, random processes, white noise, filtering random processes,spectralfactorization,ARMA,ARandMAprocesses.

Module-2

SignalModeling: Leastsquaresmethod,Padeapproximation,Prony'smethod,finitedatarecords,stochasticmodels,Levinson-Durbinrecursion;Schurrecursion;Levinsonrecursion(Text1).

Module-3

SpectrumEstimation: Nonparametricmethods,minimum-variancespectrumestimation,maximumentropymethod,parametricmethods,frequencyestimation,principalcomponentsspectrum estimation(Text1).

Module-4

OptimalandAdaptiveFiltering:FIRandIIRWienerfilters,DiscreteKalmanfilter,FIRAdaptive filters: Steepest descent, LMS, LMS-based algorithms, adaptive recursive filters, RLSalgorithms(Text1).

Module-5

ArrayProcessing: Arrayfundamentals,beam-forming,optimumarrayprocessing,performanceconsiderations,adaptivebeam-forming,linearlyconstrainedminimum-variancebeam-formers,
side-lobe cancellers.

AssessmentDetails(bothCIEandSEE)

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

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.
5. Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

SuggestedLearningResources:

TextBooks

1. MonsonH.Hayes,"StatisticalDigitalSignalProcessingandModeling",JohnWiley&Sons(Asia)Pvt. Ltd.,2002.
2. DimitrisG.Manolakis,VinayK.Ingle,andStephenM.Kogon,"StatisticalandAdaptiveSignal Processing:SpectralEstimation,SignalModeling,AdaptiveFiltering andArrayProcessing",McGraw-HillInternationalEdition,2000.

WeblinksandVideoLectures(e-Resources):

1. https://www.youtube.com/watch?v=axUcybeamIk
2. https://www.youtube.com/watch?v=sKYpHt0p7HQ

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

MiniProject inthe area ofspectrum analysis

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

MICROELECTROMECHANICALSYSTEMS			
CourseCode	22LAC243	CIEMarks	50
TeachingHours/Week(L:P: SDA)	2:0:2	SEE Marks	50
TotalHoursofPedagogy	30HoursTheory+ 10 Hours SDA	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

- UnderstandthetechnologiesrelatedtoMicroElectroMechanicalSystems.
- MEMSdevicesanalyses anddevelopsuitablemathematicalmodels
- Understandingof applicationareasforMEMSdevices
- Fabricationprocessesinvolved withMEMS devices.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

MODULE-1

OverviewofMEMSandMicrosystems:MEMSandMicrosystem,TypicalMEMSandMicrosystemsProducts,Evolution ofMicrofabrication,MicrosystemsandMicroelectronics,MultidisciplinaryNatureofMicrosystems,Miniaturization. Applications andMarkets.

MODULE-2

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

EngineeringSciencefor Microsystems Design andFabrication:
Introduction,AtomicStructureofMatters,IonsandIonization,MolecularTheoryofMatterandInter-molecularForces,DopingofSemiconductors,TheDiffusionProcess,Plasma Physics,Electrochemistry.

MODULE-3

EngineeringMechanicsforMicrosystemsDesign:Introduction,StaticBendingofThinPlates,Mechanical Vibration,Thermomechanics,FractureMechanics,ThinFilmMechanics,OverviewonFiniteElementStressAnalysis.

MODULE4

ScalingLawsinMiniaturization:

Introduction,ScalinginGeometry,ScalinginRigid-BodyDynamics,ScalinginElectrostaticForces,ScalingofElectromagneticForces,ScalinginElectricity, ScalinginFluid Mechanics,ScalinginHeatTransfer.

MODULE5

OverviewofMicro-manufacturing:Introduction,BulkMicro-manufacturing,SurfaceMicromachining,TheLIGAProcess, Summaryon Micromanufacturing.

MicrosystemDesign:Introduction,DesignConsiderations,ProcessDesign,MechanicalDesign,UsingFiniteElement Method.

AssessmentDetails(bothCIEandSEE)

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ContinuousInternalEvaluation:

- ThreeUnitTestseach of**20Marks**
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CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefined for thecourse.

SemesterEndExamination:

1. TheSEEquestionpaperwillbe setfor100marksandthemarksscoredwillbeproportionatelyreduced to50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents willhave toanswerfivefullquestions,selectingone fullquestionfromeach module

WeblinksandVideoLectures(e-Resources):

1. https://www.youtube.com/watch?v=axUcybeamIk
2. https://www.youtube.com/watch?v=sKYpHt0p7HQ

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

MiniProject inthe area ofmicrowave communication.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	-	-	1	-	-	1
CO2	3	3	3	1	1	1	-	-	1	-	-	1
CO3	3	3	3	1	1	1	-	-	1	-	-	1
CO4	3	3	3	1	1	1	-	-	1	-	-	1
CO5	3	3	3	1	1	1	-	-	1	-	-	1

ARRAYSIGNALPROCESSING			
CourseCode	22LAC244	CIEMarks	50
TeachingHours/Week(L:P: SDA)	2:0:2	SEE Marks	50
TotalHoursofPedagogy	30HoursTheory+ 10 Hours SDA	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

1. Comprehendthebasicsofsignalsinspaceandtime.
2. Understandtheimportantconceptsofarraysignalprocessing.
3. Describethevariousarraydesigntechniques.
4. Understandthebasicprincipleofdirectionofarrivalestimationtechniques.
5. ExplaintheConceptsofSpatial Frequencyalongwiththe Spatial Samplings.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

MODULE-1

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

MODULE-2

Wavenumber-FrequencySpaceSpatialSampling: SpatialSamplingTheorem-NyquistCriteria,AliasinginSpatialfrequencydomain, Spatialsamplingof multidimensionalsignals.

MODULE-3

SensorArrays: LinearArrays,PlanarArrays,Frequency–WavenumberResponseandBeampattern,Arraymanifoldvector, ConventionalBeamformer, Narrowband beamformer.

MODULE4

ScalingLawsinMiniaturization:

UniformLinearArrays: Beampatterninθ,uandψ-space,UniformlyWeightedLinear Arrays.

BeamPatternParameters: HalfPowerBeamWidth,DistancetoFirstNull,LocationofsidelobesandRateofDecrease, GratingLobes, ArraySteering.

MODULE5

ArrayDesignMethods: Visibleregion,DualitybetweenTime-DomainandSpace-DomainSignalProcessing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward-LawsonFrequency-SamplingDesign.

Nonparametricmethod -Beamforming,DelayandsumMethod, CaponsMethod.

AssessmentDetails(bothCIEandSEE)

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Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.
5. Thestudents will have toanswerfivefullQuetions,selectingonefullquestionfromeach module

TextBook:

'OptimumArrayProcessingPartIVofDetection,Estimation,andModulationTheory',HarryL.VanTrees,JohnWiley&Sons, ISBN:9780471093909, 2002.

ReferenceBooks:

. 'Array SignalProcessing:Conceptsand Techniques',DonH.Johnson,Dan E. Dugeon,PrenticeHallSignalProcessingSeries, 1stEdition, ISBN-13:978-0130485137.

. 'SpectralAnalysisofSignals',PetreStoicaandRandolphL.Moses,PrenticeHall,ISBN:0-13-113956-8,2005.

. 'ElectromagneticWavesandAntennas',SophoclesJ.Orfanidis,ECEDepartment,RutgersUniversity,94BrettRoadPiscataway,NJ88548058.http://www.ece.rutgers.edu/~orfanidi/ewa/ISBN:0-07-114243-64,2003.

WeblinksandVideoLectures(e-Resources):

1. https://www.youtube.com/watch?v=axUcybeamIk
2. https://www.youtube.com/watch?v=sKYpHt0p7HQ

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

MiniProject inthe area of

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	-	-	1	-	-	1
CO2	3	3	3	1	1	1	-	-	1	-	-	1
CO3	3	3	3	1	1	1	-	-	1	-	-	1
CO4	3	3	3	1	1	1	-	-	1	-	-	1
CO5	3	3	3	1	1	1	-	-	1	-	-	1

MATLAB-For Advanced Applications			
CourseCode	22LAC245	CIEMarks	50
TeachingHours/Week(L:P:SDA)	(2:0:2)	SEE Marks	50
TotalHoursofPedagogy	30HoursTheory+10 HoursSDA	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewillenablestudentsto:

- Definethebasicsofsimulationmodellingandreplicatingthepracticalsituationsinorganizations
- Generaterandomnumbersand randomvariatesusingdifferenttechniques.
- Developsimulationmodelusingheuristicmethods.
- AnalysisofSimulationmodelsusinginputanalyzer,andoutputanalyzer.
- ExplainVerificationandValidationofsimulationmodel.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar

Module-1

Introduction to MATLAB

MATLAB Windows, Formats, File Types, General Commands,Working with Arrays of Numbers, Creating and Printing Simple Plots, Creating, Saving, and Executing a Script File, Creating and Executing a Function File, Working with Arrays and Matrices. Symbolic Computation, Importing and Exporting Data, Working with Files and Directories, Publishing Reports.

Module-2

Interactive Computation

Matrices and Vectors, Matrix and Array Operations, Character strings, Array Operations, Command- Line Functions, Using Built-in Functions and On-line Help, Finding the determinant of a matrix Finding Eigen values and eigenvectors Saving and Loading of Data.

Module-3

Programming in MATLAB: Scripts and Functions

Executing a function, Sub functions, Nested functions, compiled (parsed) functions: The P-code Language-specific Features , Use of comments to create on-line help, Global variables, Loops branches, and control-flow, Advanced Data Objects.

Module-4

Application

Linear Algebra, solving a linear system, Gaussian elimination, Finding eigenvalues and eigenvectors, Matrix factorizations, Advanced topics, Curve Fitting and Interpolation, Polynomial curve fitting on the fly, Curve fitting with polynomial functions. Least squares curve fitting. General nonlinear fits, Interpolation, Data Analysis and Statistics, Numerical Integration, Double integration, Ordinary Differential Equations, A first-order linear ODE. A second-order nonlinear ODE, Event location, Nonlinear Algebraic Equations, Roots of polynomials.

Module-5

UNIT-5: Graphics

Basic 2-D Plots, Style options ,Labels, title, legend, and other text objects ,Axis control, zoom in, and zoom out, Modifying plots with the plot editor, Overlay plots , Specialized 2-D plots ,subplot for Multiple Graphs, 3-D Plots, Rotate view .Mesh and surface plots, Vector field and volumetric plot, Interpolated surface plots, Handle Graphics, The object hierarchy, Object handles ,Object properties ,Modifying an existing plot, Complete control over the graphics layout Fun with 3-D Surface Graphics, Saving and Printing Graphs

AssessmentDetails(bothCIEandSEE)

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ContinuousInternalEvaluation:

1. Three UnitTests eachof**20Marks**
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toattainthe COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50 marks.

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

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
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5. Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

SuggestedLearningResources:

TextBooks

1. C.F. Van Loan and K.-Y.D. Fan, Insight Through Computing: A MATLAB Introduction to Computational Science and Engineering, SIAM, 2010

ReferenceBooks:

1. Rudra Pratap, Getting Started with MATLAB-Oxford University Press-2017, ISBN: 978-0-19-060206-2

WeblinksandVideoLectures(e-Resources):NPTEL, Youtube Videos
Courseoutcome(CourseSkill Set) At theend ofthe coursethestudent willbeable to: • Understand General Command of MATLAB and working with array numbers • Analyze command line functions and Find Eigen values and Eigenvectors • Able to do Programming in Matlab Scripts and Functions • Apply MATLAB in different applications

MappingofCOSandPOs

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

IIISEMESTER

Microwave Devices and its Applications			
CourseCode	22LAC31	CIEMarks	50
TeachingHours/Week(L:P:SDA)	(3:0:2)	SEE Marks	50
TotalHoursofPedagogy	40HoursTheory+ 10 Hours SDA	TotalMarks	100
Credits	04	ExamHours	3

CourseLearningobjectives:

1. Understand fundamental electrical characteristics of waveguides and transmission lines through electromagnetic field analysis.
2. Understand the concept of circular waveguides, micro strip lines and cavity resonators
3. Understand the multiport junction concept for splitting the microwave energy in a desired direction
4. Understand the concept of O type Tubes, M type tubes and related expressions in microwaves.
5. Understand the function, design, and integration of the major microwave components like oscillator, modulator, in building a Microwave test bench setup for measurements

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1
MICROWAVE TRANSMISSION LINES Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Rectangular Waveguides– TE/TM mode analysis, Expressions for Fields, Characteristic Equation and Cut-off Frequencies, Filter Characteristics, Dominant and Degenerate Modes, Sketches of TE and TM mode fields in the cross-section, Mode Characteristics – Phase and Group Velocities, Wavelengths and Impedance Relations; Power Transmission and Power Losses in Rectangular Guide, Impossibility of TEM mode. Related Problems.
Module-2
CIRCULAR WAVEGUIDES Introduction, Nature of Fields, Characteristic Equation, Dominant and Degenerate Modes. Microstrip Lines– Introduction, Zo Relations, Effective Dielectric Constant, Losses, Q factor. Cavity Resonators– Introduction, Rectangular and Cylindrical Cavities, Dominant Modes and Resonant Frequencies, Q factor and Coupling Coefficients, Excitation techniques- waveguides and cavities, Related Problems.
Module-3
WAVEGUIDE COMPONENTS AND APPLICATIONS - I Coupling Mechanisms – Probe, Loop, Aperture types. Waveguide Discontinuities –Waveguide irises, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Resistive Card, Rotary Vane types; Waveguide Phase Shifters– Dielectric, Rotary Vane types. Scattering Matrix– Significance, Formulation and Properties. S-Matrix Calculations for – 2 port Junction, E plane and H-plane Tees, Magic Tee, Hybrid Ring; Directional Couplers –2Hole, Bethe Hole types, Ferrite Components– Faraday Rotation, S-Matrix Calculations for Gyrator, Isolator, Circulator, Related Problems
Module-4
MICROWAVE TUBES Limitations and Losses of conventional tubes at microwave frequencies. Microwave tubes – O type and M type classifications. O-type tubes : 2 Cavity Klystrons – Structure, Reentrant Cavities, Velocity Modulation Process and Applegate Diagram, Bunching Process and Small Signal Theory – Expressions for o/p Power and Efficiency. Reflex Klystrons – Structure, Applegate Diagram and Principle of working, Mathematical Theory of Bunching, Power Output, Efficiency, Electronic Admittance; Oscillating Modes and o/p Characteristics, Electronic and Mechanical Tuning, Related Problems. **HELIX TWTS** Significance, Types and Characteristics of Slow Wave Structures; Structure of TWT and Suppression of Oscillations, Nature of the four Propagation Constants. **M-TYPE TUBES** Introduction, Cross-field effects, Magnetrons – Different Types, 8-Cavity Cylindrical Travelling Wave. Magnetron – Hull Cut-off and Hartree Conditions, Modes of Resonance and PI-Mode Operation, Separation of PI-Mode, o/p characteristics.
Module-5

MICROWAVE SOLID STATE DEVICES

Introduction, Classification, Applications. TEDs – Introduction, Gunn Diode – Principle, RWH Theory, Characteristics, Basic Modes of Operation, Oscillation Modes. Avalanche Transit Time Devices – Introduction, IMPATT and TRAPATT Diodes – Principle of Operation and Characteristics.

MICROWAVE MEASUREMENTS

Description of Microwave Bench – Different Blocks and their Features, Precautions; Microwave Power Measurement – Bolometer Method. Measurement of Attenuation, Frequency, VSWR, Cavity Q. Impedance Measurements.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Twoassignmentseachof **20Marks**or **oneSkillDevelopmentActivityof40marks**

toattainthe COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefinedfor the course.

SemesterEndExamination:

1. TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.
5. Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

SuggestedLearningResources:

Textbooks:

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rdEdition,1994.
2. Microwave Principles – Herbert J. Reich, J.G. Skalnik, P.F. OrdungandH.L. Krauss, CBS Publishers and Distributors, New Delhi, 2004.
3. Microwave and Radar Engineering – M.Kukarni, 4th Edition, 1990.

ReferenceBooks:

4. Foundations for Microwave Engineering – R.E. Collin, IEEE Press,John Wiley, 2nd Edition, 2002.
5. Microwave Engineering- David M.Pozarwiley, $th edition,2012.
6. Microwave Engineering Passive Circuits – Peter A. Rizzi, PHI, 1999.

WeblinksandVideoLectures(e-Resources):nptel, youtube videos

Course Outcomes: After Successful completion of the course, students should be able to:

- Analyzation of transmission lines and rectangular waveguide structures and how they are used as elements in impedance matching and filter circuits.
- Analyze Circular Waveguide and microstrip lines
- Apply analysis methods to determine circuit properties of passive or active microwave devices
- Describe different types of tubes used in transmission
- Analyze and measure various microwave parameters using a Microwave test bench.

MappingofCOSandPos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**1**	**-**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**-**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**1**	**-**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**-**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**-**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

PROFESSIONALELECTIVE3

ADVANCESINIMAGEPROCESSING			
Course Code	22LAC321	CIEMarks	50
TeachingHours/Week(L:P: SDA)	3:0:0	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

1. Understandtherepresentationofthedigitalimageanditsproperties.
2. Applypre-processingtechniquesrequiredtoenhancetheimageforitsfurtheranalysis.
3. Usesegmentationtechniquestoselecttheregionofinterestintheimage foranalysis.
4. Representtheimagebasedonitsshapeandedgeinformationandalsodescribetheobjectspresentintheimagebased on its properties andstructure.
5. Usemorphologicaloperationstosimplifyimages,andquantifyandpreservethemainshapecharacteristics oftheobjects.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

MODULE-1

Theimage, its representationsand properties:Imagerepresentations a few concepts, Image digitization, Digitalimageproperties, Color images.

MODULE-2

ImagePre-processing:Pixel brightnesstransformations,geometrictransformations,localpre-processing.

MODULE-3

Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Bordertracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting andmerging,Watershed segmentation,Region growingpost-processing.

MODULE4

Shaperepresentationanddescription:Regionidentification;Contour-basedshaperepresentationanddescription– Chaincodes,Simplegeometricborderrepresentation,Fouriertransformsofboundaries, Boundarydescription usingsegment sequences, B-spline representation; Region-based shape representation and description – Simple scalarregiondescriptors, Moments, Convex hull.

MODULE5

MathematicalMorphology:Basicmorphologicalconcepts,Fourmorphologicalprinciples,Binarydilationanderosion, Skeletonsandobjectmarking,Morphologicalsegmentationsandwatersheds.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

- ThreeUnitTestseach of**20Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Each fullquestion is for 20 marks.Therewill be two fullquestions(with amaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents willhave toanswerfivefullquestions,selectingone fullquestion fromeach module.

WeblinksandVideoLectures(e-Resources):

3. https://www.youtube.com/watch?v=axUcybeamIk
4. https://www.youtube.com/watch?v=sKYpHt0p7HQ

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning **MiniProject inthe area ofAntenna design usingmodern tools likeCST, HFSS**

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Understand the representation of the digital image and its properties.
- Apply pre-processing techniques required to enhance the image for its further analysis.
- Use segmentation techniques to select the region of interest in the image for analysis.
- 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.
- Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**1**	**1**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

INTERNETOFTHINGS			
CourseCode	22LAC322	CIEMarks	50
TeachingHours/Week(L:P:SDA)	(3:0:0)	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewillenablestudentsto:

- Understandthechallengesand historybehindInternetofthings.
- DesignthenetworkarchitectureandLayeredstructureofIoT.
- UnderstandtheThingsinIoTandthe variousTechnologiesinvolved.
- 4.Applytheconceptsof IoTinthreedifferent usecases.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

WHAT IS IOT? Genesis, Digitization, Impact, Connected Roadways, Buildings, Challenges **IoT NetworkArchitecture and Design** Drivers behind new network Architectures, Comparing IoT Architectures, M2Marchitecture,IoT worldforumstandard, IoT ReferenceModel,Simplified IoT Architecture.

Module-2

IOT NETWORK ARCHITECTURE AND DESIGN: Core IoT Functional Stack, Layer1 (Sensors andActuators), Layer 2 (Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer,Network transport sublayer, IoT Network management. Layer 3 (Applications and Analytics) – Analytics vsControl,Data vsNetworkAnalytics, IoT DataManagementandCompute Stack.

Module-3

ENGINEERING IOT NETWORKS: Things in IoT – Sensors, Actuators, MEMS and smart objects. Sensornetworks,WSN,CommunicationprotocolsforWSNCommunicationsCriteria,Range,Frequency bands,power consumption, Topology, Constrained Devices, Constrained Node Networks IoT Access Technologies,IEEE802.15.4CompetitiveTechnologies–OverviewonlyofIEEE802.15.4g,4e,IEEE1901.2aStandard Alliances–LTECat 0,LTE-M,NB-IoT.

Module-4

ENGINEERING IOT NETWORKS: IP as IoT network layer, Key Advantages, Adoption, Optimization,Constrained Nodes, Constrained Networks, IP versions, Optimizing IP for IoT. Application Protocols for IoT –Transport Layer, Application Transport layer, Background only of SCADA, Generic web-based protocols, IoTApplicationLayer DataandAnalyticsforIoT–Introduction,StructuredandUnstructureddata,IoTData AnalyticsoverviewandChallenges.

Module-5

IoT in Industry (Three Use cases): IoT Strategy for Connected manufacturing, Architecture for ConnectedFactory Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primarysubstation grid block and automation. Smart and Connected cities –Strategy, Smart city network Architecture,Streetlayer,citylayer,Datacenterlayer,serviceslayer,Smart citysecurityarchitecture,Smart Streetlighting.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. Three UnitTests eachof**20Marks**
2. Twoassignmentseachof**20Marks**or **oneSkillDevelopmentActivityof40marks**

toattainthe COsand POs

Thesumofthreetests,twoassignments/skillDevelopmentActivities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Each fullquestion is for 20 marks.Therewill be two fullquestions(withamaximum offoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.
5. Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

SuggestedLearningResources:

Books

1. 'CISCO, IoT Fundamentals – Networking Technologies, Protocols, Use Cases for IoT', David Hanes,Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Pearson Education, ISBN: 978-9386873743, First edition,2017
2. 'InternetofThings–AHandsonApproach',ArshdeepBahgaandVijayMadisetti,OrientBlackswan PrivateLimited -NewDelhi,First edition,2015

WeblinksandVideoLectures(e-Resources):

MassiveOpenOnlineCourses:

1. Introductionto Internet ofThings-ByProf. Sudip Misra|IITKharagpur
2. AnIntroductiontoProgrammingtheInternetofThings-COURSERAUniversityofCalifornia,Irvine

SkillDevelopmentActivitiesSuggested

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare aresearchArticle.
- IndustrialVisitor Seminaron anynew topic.

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Understand the basic concepts IoT Architecture and devices employed.
- Analyse the sensor data generated and map it to IoT protocol stack for transport.
- Apply communications knowledge to facilitate transport of IoT data over various available communications media.
- Design a use case for a typical application in real life ranging from sensing devices to analysing the data available on a server to perform tasks on the device.
- Apply knowledge of Information technology to design of IoT applications (Operational Technology).

MappingofCOSandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	1	3	1	2	-	-	-	-	-	2
CO2	1	-	1	3	1	2	-	-	-	-	-	2
CO3	1	-	1	3	1	2	-	-	-	-	-	2
CO4	1	1	1	3	1	2	-	-	-	-	-	1
CO5	1	1	1	3	1	2	-	-	-	-	-	1

REALTIMESYSTEMS			
CourseCode	22LAC323	CIEMarks	50
TeachingHours/Week(L:P:SDA)	(3:0:0)	SEEMarks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	3

CourseLearningobjectives: Thiscoursewillenablestudentsto:

- AnalyzeRealtimeoperatingsystems.
- Distinguishareal-timesystemwithothersystems.
- DescribethefunctionsofRealtimeoperatingsystems
- Demonstrateembeddedsystemapplications.
- DesignaRealTimeoperatingsystem.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

Introduction to Real-Time Embedded Systems: Brief history of Real Time Systems, A brief history ofEmbedded Systems. System Resources:Resource Analysis, Real-Time Service Utility, Scheduling Classes,The Cyclic Executive, Scheduler Concepts, Pre-emptive Fixed Priority Scheduling Policies, Real-Time OS,ThreadSafe Re-entrantFunctions.(TEXT1).

Module-2

Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary andSufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies. I/O Resources: Worst-caseExecutiontime,IntermediateI/O,Executionefficiency,I/OArchitecture.Memory:Physicalhierarchy,Capacityandallocation,SharedMemory,ECCMemory,Flashfilesystems.(TEXT 1)

Module-3

Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources,priority inversion. Soft Real-Time Services: Missed Deadlines, QoS, and Alternatives to rate monotonic policy,Mixedhardand softreal-timeservices. (TEXT1).

Module-4

HardwareforReal-TimeSystems:BasicProcessorArchitecture,MemoryTechnologies,ArchitecturalAdvancements,PeripheralInterfacing,MicroprocessorversusMicrocontroller,DistributedReal-TimeArchitectures.(TEXT 2).

Module-5

PerformanceTuning: Basicconceptsofdrill-downtuning,hardware–supportedprofiling andtracing,Buildingperformance monitoringintosoftware, Pathlength.

High availability and Reliability Design: Reliability and Availability, Similarities and differences, Reliability,Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design.(TEXT1)

AssessmentDetails(bothCIEandSEE)

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ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.
5. Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

SuggestedLearningResources:

Textbooks:

1. '"Real-TimeEmbeddedSystemsandComponents",SamSiewert,CengageLearningIndiaEdition,2007.
2. "Real-TimeSystems Design and Analysis", Phillip A.Laplante,JohnWiley&Sons, 2004.

ReferenceBooks:

1. "Realtimesystems",KrishnaCMandKangSinghG,TataMcGrawHill,ISBN:0-07-114243-64,2003
2. "Real-TimeConceptsforEmbeddedSystems",QingLiandCarolynYao,CMPBooks,ISBN:1578201241, 2003.
3. "RealTimeSystems",JaneW.S.Liu,PrenticeHall,ISBN: 0130996513,2000.

WeblinksandVideoLectures(e-Resources):

- https://youtube.com/playlist?list=PL5Q2soXY2Zi9xidyIgBxUz7xRPS-wisBN

SkillDevelopmentActivitiesSuggested

- DesignSchedulingAlgorithms.
- AnalysingDeviceDriverProgramming

Courseoutcome(CourseSkill Set)

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At theend ofthe coursethestudent willbeable to:

- Analyze Real time operating systems.
- Distinguish a real-time system with other systems.
- Describe the functions of Real time operating systems
- Demonstrate embedded system applications.
- Design a Real Time operating system.

MappingofCOSandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

RFMEMS			
CourseCode	22LAC324	CIEMarks	50
TeachingHours/Week(L:P:SDA)	(3:0:0)	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	3

CourseLearningobjectives: Thiscoursewillenablestudentsto:

- ComprehendtheneedformicromachiningandMEMSbasedsystemsfor RFandmicrowaveapplications
- Describethemicromachiningtechniques and theiruseinthefabrication of microswitches,capacitorsand inductors
- DesignMEMSbasedmicrowavecomponentsaimedatreducinginsertionlossandincreasingbandwidth.
- RealizehighQmicromechanicalfiltersforfrequenciesuptoand beyond10MHz,andmicromachinedsurfaceacoustic wave (SAW) filtersfillingthe gapup to2GHz.
- Describethepackagingapproachesusedfor theseRFMEMS devices

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

Review: Introduction to MEMS: Fabrication for MEMS transducers and actuators, Microsensing forMEMS,MaterialsforMEMS.MEMSmaterialsandfabricationtechniques:Metals,Semiconductors,Thinfilms,Materialsfor polymer MEMS,Bulkmachining for Silicon basedMEMS, Surfacemachiningfor Silicon based MEMS, Micro stereo-lithographyforpolymer MEMS.

Module-2

RFMEMSSwitchesandmicro-relays:Switchparameters,Basicsofswitching,SwitchesforRFand Microwave applications, Actuation mechanisms, Micro-relays and micro-actuators, Dynamic ofswitchoperations;MEMSswitchdesignanddesignconsideration,MEMSinductorsandcapacitors.

Module-3

Micro machined RF filters and phase shifters: RF filters, Modelling of mechanical filters, Micro-mechanical filters, SAW filters - Basic, Design consideration. Bulk acoustic wave filters, Micro-machinedfiltersformillimetrewavefrequencies.Micro-machinedphaseshifters,Typesandlimitations,MEMSand Ferroelectricphaseshifters,Applications.

Module-4

Micromachinedtransmissionlineandcomponents:Micromachinedtransmissionline:Lossesin transmissionline,coplanarlines,Microshieldandmembranesupportedlines,Microshieldcomponents,Micromachinedwaveguides,DirectionalcouplersandMixers, ResonatorsandFilters

Module-5

Micromachined antennas: design, Fabrication and measurements. Integration and packaging for RFMEMS. Roles and types of packages, Flip chip techniques, Multichip module packaging and Waferbonding,Reliabilityissues and thermal issues.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Twoassignmentseachof **20Marks**or **oneSkillDevelopmentActivityof40marks**

toattainthe COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefinedfor the course.

SemesterEndExamination:

1. TheSEE questionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.
5. Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Text Book:'RFMEMSandtheirApplications',VijayKVaradan,K.J.VinoyandK.A.Jose,WileyIndia Pvt.Ltd.,ISBN-10 : 8126529911,2011.

Referencebooks:

1. 'RFMEMScircuitdesign',JDeLosSantos,ArtechHouse,2002.
2. 'TransactionLevelModellingwithSystem C:TLMconceptsandapplicationsforEmbeddedSystems',Frank Ghenassia, Springer, 2005.
3.'Networksonchips:TechnologyandTools',LucaBeninid,MorganKaufmannPublishers,2006.

SkillDevelopmentActivitiesSuggested

- RF&Millimeterwavecircuitdesign
- Microwaveactivecircuit design

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Comprehend the need for micromachining and MEMS based systems for RF and microwave applications
- Describe the micromachining techniques and their use in the fabrication of micro switches, capacitors and inductors
- Design MEMS based microwave components aimed at reducing insertion loss and increasing bandwidth
- Realize high Q micromechanical filters for frequencies up to and beyond 10 MHz, and micromachined surface acoustic wave (SAW) filters filling the gap up to 2 GHz
- Describe the packaging approaches used for these RF MEMS devices.

MappingofCOSandPOs

	PO1	**PO2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO1 0**	**PO11**	**PO12**
CO1	**1**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**1**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**2**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**2**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**1**

5G-Radio Access Technologies			
CourseCode	22LAC325	CIEMarks	50
TeachingHours/Week(L:P: SDA)	(3:0:0)	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

1. 5G channel modelling and use cases
2. Get Idea on Multiple-input multiple-output (MIMO) systems
3. To know about 5G architecture and Importance of 5G Technology
4. To understand Device-to-de vice (D2D) communication and standardization
5. Analyze the 5G radio-access technologies

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

MODULE-1

5G ChannelModellingandUseCases

Modelingrequirementsandscenarios, Channelmodelrequirements,Propagation scenarios, Relayingmulti-hopandcooperativecommunications:Principlesofrelaying,fundamentals ofrelaying,Cognitiveradio:Architecture,spectrum sensing,SoftwareDefinedRadio(SDR).

MODULE-2

Multiple-input multiple-output (MIMO) systems

Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems. Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing.

MODULE-3

The 5G architecture

Introduction,NFVandSDN,BasicsaboutRANarchitecture,High-levelrequirementsforthe5Garchitecture,Functionalarchitectureand5Gflexibility,Functionalsplitcriteria,Functionalsplit alternatives, Functional optimization for specificapplications, Integration of LTEand new airinterfaceto fulfill5GRequirements, Enhanced Multi-RAT coordinate features, Physicalarchitectureand5Gdeployment.

MODULE4

Device-to-device(D2D)communicationsD2D: from 4G to 5G, D2D standardization: 4G LTE D2D, D2D in5G: research challenges, Radio resource management for mobilebroadbandD2D, RRMtechniquesfor mobilebroadbandD2D,RRMandsystem designfor D2D, 5G D2D RRM concept: anexample,Multi-hopD2Dcommunicationsforproximityandemergency,services,Nationalsecurityandpublicsafetyrequirements in3GPPandMETIS,Devicediscoverywithoutand withnetworkassistance.

MODULE 5

Accessdesignprinciplesformulti-usercommunications,Orthogonal multiple-accesssystems,Spreadspectrum multiple-accesssystems,Capacitylimitsofmultiple-access methods,Sparse code multiple access (SCMA), Interleave division multipleaccess(IDMA),Radioaccessfordensedeployments,OFDMnumerologyforsmall-celldeployments,Small-cellsub-framestructure,RadioaccessforV2Xcommunication,Mediumaccess control for nodesonthe move, Radio access for massive machine-typecommunication.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

- ThreeUnitTestseach of**20Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Each fullquestion is for 20 marks.Therewill be two fullquestions(withamaximum offoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

TextBook:

1. AfifOsseiran,JoseF.Monserrat,Patrick Marsch, 5GMobileand WirelessCommunicationsTechnology, CambridgeUniversityPress, SecondEdition, 2011
2. ErikDahlman,StefanParkvall,JohanSköld ,5GNR:TheNextGenerationWireless AccessTechnology,Elsevier ,FirstEdition, 2016

ReferenceBooks:

1. JonathanRodriguez Fundamentalsof5GMobileNetworks, Wiley, First Edition, 2010.

OnlineReferences:

Sr. No.	WebsiteName	URL	ModulesCovered
1	NPTEL	https://nptel.ac.in/courses/108/105/108105134/	M1,M2,M3,M4,M5
2	Udemy	https://www.udemy.com/course/5g-mobile-networks-modern-wireless-communication-technology/	M4,M5

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Understand and explain the channel models of 5G and the use cases for 5G.
- Analyze use of MIMO in 5G and its techniques.
- Draw and explain 5G architecture, its components and functional criteria.
- Understand device to device (D2D) communication and standardization.
- Study the in-depth functioning of 5G radio access technologies.

Mapping of Co and PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**1**	**1**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

PROFESSIONALELECTIVE4

PATTERNRECOGNITIONANDMACHINELEARNING			
CourseCode	22LAC331	CIEMarks	50
TeachingHours/Week(L:P:SDA)	(3:0:0)	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewillenablestudentsto:

- Developthemathematical toolsrequiredforthepatternrecognition.
- Enable thestudentwithbasicknowledgeonthetechniquestobuildanintellectualmachineformakingdecisionsbehalf of humans.
- Understandthetechniquesonhowtomakelearningbyamodel,howitcanbeevaluated,whatareall differentalgorithmstoconstruct alearningmodel.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

Module-1

Introduction: DefinitionofPR,Applications,DatasetsforPR,DifferentparadigmsforPR,Introductionto probability,events,randomvariables,Jointdistributionsanddensities,moments,Estimationminimumriskestimators,problems.

Module-2

Representation: Data structures for PR, Representation of clusters, proximity measures, size of patterns,AbstractionofDataset,Featureextraction,Featureselection,Evaluation

Module-3

Nearest Neighbor based classifiers & Bayes classifier: Nearest neighbor algorithm, variants of NN algorithmsuse of NN for transaction databases, efficient algorithms, Data reduction, prototype selection, Bayes theorem,minimumerrorrateclassifier,estimationofprobabilities,estimationofprobabilities,comparisonwithNNC, NaiveBayesclassifier,Bayessianbeliefnetwork.

Module-4

Machine Learning Basics: Learning Algorithms, Capacity, Overfitting and Underfitting,HyperparametersandValidationSets,Estimator,BiasandVariance,MaximumLikelihoodEstimation,BayesianStatistics,SupervisedLearningAlgorithms,UnsupervisedLearningAlgorithms,StochasticGradientDecent,buildinga MachineLearningAlgorithm,ChallengesMotivatingDeepLearning.

Module-5

Optimization for Training Deep Models: How Learning Differs from Pure Optimization, Challenges inNeural Network Optimization, Basic Algorithms. Parameter Initialization Strategies, Algorithms with AdaptiveLearningRates.

Convolutional Networks: The Convolution Operation, Motivation, Pooling, Convolution and Pooling as anInfinitelyStrong

Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient

ConvolutionAlgorithms,RandomorUnsupervisedFeatures.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseach of**20Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks.

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

SemesterEndExamination:

1. TheSEE questionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto 50.
2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.
5. Thestudents will have toanswerfive fullquestions,selectingone fullquestion fromeachmodule

SuggestedLearningResources:

TextBooks

1. "Pattern Recognition (An Introduction)", V Susheela Devi, M Narsimha Murthy, Universities Press,2011.
2. "PatternRecognition&ImageAnalysis",EarlGose,RichardJohnsonbaugh,Steve Jost,PH,1996.
3. "DeepLearning",LanGoodfellowandYoshuaBengioandAaronCourville,MIT Press,2016.

ReferenceBooks:

1. 'PatternClassification',DudaR.O.,P.E.Hart,D.G.Stork,JohnWileyandsons,2000.
2. "PatternRecognitionandmachineLearning",Chirstopher Bishop,2007.

WeblinksandVideoLectures(e-Resources):

- https://link.springer.com› book
- https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf
- http://cgm.cs.mcgill.ca/~godfried/teaching/pr-web.html

SkillDevelopmentActivitiesSuggested

- ProgrammingAssignments/MiniProjectscanbegiventoimproveprogrammingskills.
- Onlinecoursecertificationrelatedtothisfield may beincluded.

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Explain pattern recognition principals.
- Develop algorithms for Pattern Recognition.
- Design the nearest neighbor classifier.
- Identify the deep learning algorithms which are more appropriate for various types of learning tasks.
- Implement deep learning algorithms and Execute performance metrics of Deep
- Learning Techniques.

MappingofCOSandPos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**2**	**1**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**2**	**1**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**

VLSI DESIGN FOR SIGNAL PROCESSING			
CourseCode	22LAC332	CIEMarks	50
TeachingHours/Week(L:P: SDA)	(3:0:0)	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

1Illustratetheuseofvarious DSPalgorithmsandaddressestheirrepresentationusingblockdiagrams,signalflowgraphs anddata-flowgraphs

2. Usepipeliningandparallelprocessingindesignofhigh-speed/low-power applications
3. Applyunfoldinginthedesignofparallelarchitecture
4. Evaluatetheuseoflook-aheadtechniquesinparallelandpipelinedIIR Digitalfilters.
5. Developanalgorithmorarchitectureorcircuit designforDSPapplications

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

MODULE-1

IntroductiontoDSPSystems:TypicalDSPAlgorithms,DSPApplicationDemandsandScaledCMOSTechnologies,Representations ofDSPAlgorithms.

IterationBounds:DataflowgraphRepresentations,loopboundandIterationbound.AlgorithmsforComputingIteration Bound, Iteration Boundof multirate dataflowgraphs.

MODULE-2

Pipelining and Parallel Processing: pipelining of FIR Digital Filters, parallel processing, Pipelining andparallel processing for low power.**Retiming**: Definition and Properties, Solving Systems of Inequalities,RetimingTechniques.

MODULE-3

Unfolding:AnAlgorithmforUnfolding,PropertiesofUnfolding,Criticalpath,UnfoldingandRetiming,Applicationof Unfolding.

Folding:FoldingTransformation,RegisterMinimizationTechniques,RegisterMinimizationinFoldedArchitectures,FoldingofMultirate Systems.

MODULE4

Systolic Architecture Design: systolic array design Methodology, FIR systolic array, Selection of SchedulingVector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design for space representationcontainingDelays.

Fastconvolution:Cook-ToomAlgorithm,WinogradAlgorithm,Iteratedconvolution,cyclicconvolutionDesignoffastconvolutionAlgorithmby Inspection.

MODULE5

Pipelined and Parallel Recursive and Adaptive Filter: Pipeline Interleaving in Digital Filter, first order IIRdigital Filter, Higher order IIR digital Filter, parallel processing for IIR filter, Combined pipelining and parallelprocessing for IIR Filter, Low power IIR Filter Design Using Pipelining and parallel processing, pipelinedadaptivedigitalfilter.

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether.

ContinuousInternalEvaluation:

- ThreeUnitTestseach of**20Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs

Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50 marks.

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

SemesterEndExamination:

1.TheSEEquestionpaper will besetfor100marksandthemarks scoredwill beproportionatelyreducedto 50.

2. Thequestionpaperwill havetenfull questionscarryingequal marks.
3. Each fullquestion is for 20 marks.Therewill be two fullquestions(withamaximum offoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Text Book

1. VLSIDigitalSignal Processingsystems, DesignandimplementationKeshabK.ParthiWiley1999

ReferenceBook

1 AnalogVLSISignalandInformationProcessingMohammedIsamailandTerriFiezMcGraw-Hill1994

2 VLSIand Modern Signal Processing S.Y.Kung, H.J.WhiteHouse,T.KailathPrenticeHall 1985

3 DesignofAnalog-DigitalVLSICircuitsforTelecommunicationandSignalProcessingJoseE.France,YannisTsividis Prentice Hall1994

4 DSPIntegratedCircuits LarsWanhammar AcademicPressSeriesinEngineering1st Edition

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Illustrate the use of various DSP algorithms and addresses their representation using block diagrams, signal flow graphs and data-flow graphs
- Use pipelining and parallel processing in design of high-speed /low-power
- Apply unfolding in the design of parallel architecture
- Evaluate the use of look-ahead techniques in parallel and pipelined IIR Digital filters.
- Develop an algorithm or architecture or circuit design for DSP applications

MappingofCOSandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	1	1	-	-	-	-	-	2
CO2	1	1	1	2	1	1	-	-	-	-	-	2
CO3	2	1	2	1	1	1	-	-	-	-	-	2
CO4	1	1	1	2	1	1	-	-	-	-	-	1
CO5	1	1	2	1	1	1	-	-	-	-	-	1

DIGITALCOMPRESSION			
CourseCode	22LAC333	CIEMarks	50
TeachingHours/Week(L:P: SDA)	3:0:0	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

1Explaintheevolutionandfundamentalconceptsof Data CompressionandCodingtechniques.

2. AcquirecontemporaryknowledgeinDataCompressionandCoding.
3. Analyzetheoperation ofa rangeof commonlyusedCodingand Compressiontechniques
4. Identifythebasicsoftwareandhardwaretoolsusedfordatacompression.
5. Analyzeandevaluatetheperformanceofdifferent DataCompressionandCodingmethods.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

MODULE-1

Introduction: Compression techniques, Modelling & coding, Distortion criteria, Differential Entropy, RateDistortion Theory, Vector Spaces, Information theory, Models for sources, Coding uniquely decodable codes,Prefixcodes,KraftMcMillan Inequality.

Quantization: Quantization problem, Uniform Quantizer, Adaptive Quantization, Non-uniform Quantization;EntropycodedQuantization,VectorQuantization,LBGalgorithm,TreestructuredVQ,StructuredVQ.

MODULE-2

DifferentialEncoding: Basicalgorithm,PredictioninDPCM,AdaptiveDPCM,DeltaModulation,Speechcoding–G.726,Image coding.

TransformCoding: Transforms–KLT,DCT,DST,DWHT;Quantizationandcodingoftransformcoefficients,Application toImage compression–JPEG, Applicationtoaudio compression.

MODULE-3

Sub-bandCoding: Filters,Sub-bandcodingalgorithm,Designoffilterbanks,Perfectreconstructionusingtwo channel filter banks, M-band QMF filter banks, Poly-phase decomposition, Bit allocation, Speech coding–G.722,Audiocoding–MPEGaudio, Image compression.

MODULE4
Wavelet Based Compression: Wavelets, Multi resolution analysis & scaling function, Implementation usingfilters,Image compression–EZW, SPIHT, JPEG2000. **Analysis/SynthesisSchemes:**Speechcompression–LPC10,CELP,MELP.**VideoCompression:**Motioncompensation, Video signal representation, Algorithms for video conferencing & video phones–H.261, H.263,Asymmetricapplications–MPEG4, MPEG7, Packetvideo.
MODULE5
Loss less Coding: Huffman coding, Adaptive Huffman coding, Golomb codes, Rice codes, Tunstall codes,Applications of Huffman coding, Arithmetic coding, Algorithm implementation, Applications of Arithmeticcoding,Dictionarytechniques–LZ77,LZ78,ApplicationsofLZ78–JBIG,JBIG2,Predictivecoding–Predictionwithpartialmatch,BurrowsWheelerTransform,Applications– CALIC,JPEG-LS.
AssessmentDetails(bothCIEandSEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether. **ContinuousInternalEvaluation:** • ThreeUnitTestseach of**20Marks** • Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per theoutcomedefinedfor the course.** **SemesterEndExamination:** 1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50. 2. Thequestionpaperwill havetenfull questionscarryingequalmarks.

3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfive fullquestions,selectingone fullquestionfromeachmodule

Textbook:

'IntroductiontoDataCompression',KSayood,HarcourtIndiaPvt.Ltd.&MorganKaufmannPublishers,1996.

ReferenceBooks:

'DigitalCodingofWaveforms:PrinciplesandApplicationstoSpeechandVideo',NJayantandPNoll,PrenticeHall, USA, 1984.

2. 'DataCompression:TheComplete Reference',DSalomon,Springer, 2000.

3. 'FundamentalsofMultimedia', ZLi andM SDrew,Pearson Education(Asia) Pvt.Ltd.,2004

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Explain the evolution and fundamental concepts of Data Compression and Coding techniques.
- Acquire contemporary knowledge in Data Compression and Coding.
- Analyze the operation of a range of commonly used Coding and Compression techniques
- Identify the basic software and hardware tools used for data compression.
- Analyze and evaluate the performance of different Data Compression and Coding methods

MappingofCOSandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**1**	**1**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

WAVELETTRANSFORMSANDAPPLICATIONS			
CourseCode	22LAC334	CIEMarks	50
TeachingHours/Week(L:P: SDA)	3:0:0	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

1. 1Classifyvarious waveletransformand explainimportanceofit.
2. DescribeContinuous WaveletTransform(CWT)andDiscreteWaveletTransform(DWT).
3. Explainthepropertiesandapplicationofwaveletransform.
4. Developandrealizecomputationallyefficientwavelet-basedalgorithmsforsignalandimageprocessing.
5. Explainbrieffeaturesandstrengthoftransformbeyondwavelet.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

MODULE-1

ContinuousWaveletTransform: Continuoustimefrequencyrepresentationofsignals,TheWindowedFourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, specifications, admissibilityconditions,Continuouswavelet transform, CWTasacorrelation, CWTasanoperator, 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, Digitalfiltering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generatingwavelets,interpretingorthonormalMRAforDiscretetimesignals,MallatalgorithmFilterbankimplementationof DWT.

MODULE-3

Alternative wavelet representations- Biorthogonal Wavelets: biorthogonality in vector space, biorthogonalwavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets,biorthogonalanalysisandsynthesis,Filterbankimplementation,TwodimensionalWavelets,filterbankimplementationoftwo-dimensionalwavelettransform.

MODULE4
Lifting scheme: Wavelet Transform using polyphase matrix factorization, Geometrical foundations of theliftingscheme,liftingschemeinthez-domain,mathematicalpreliminariesforpolyphasefactorization,Dealingwith SignalBoundary.
MODULE5
Applications: ImageCompression:EZWCoding,SPIHT,WaveletDifferenceReductionCompressionAlgorithm,Denois ing,speckleremoval,edgedetectionandobjectisolation,audiocompression,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 letconstruction,Propertiesand applications.
AssessmentDetails(bothCIEandSEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether. **ContinuousInternalEvaluation:** • ThreeUnitTestseach of**20Marks** • Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per theoutcomedefinedfor the course.** **SemesterEndExamination:** 1.TheSEEquestionpaper will besetfor100marksandthemarks scoredwill beproportionatelyreducedto 50.

2. Thequestionpaperwill havetenfull questionscarryingequalmarks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeach module.
4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents will have toanswerfivefullquestions,selectingonefullquestionfromeach module

Textbook:

- WaveletTransforms–Introductionandapplications-RaguveerM.RaoandAjitS.Bopardikar-PearsonEducation, 2008
- InsightintoWaveletsfromTheorytopractice - K.PSoman,K. I.Ramachandran,PHI,2006
- FundamentalsofWavelets:Theory,AlgorithmsandApplications-JCGoswamyandAKChan,WileyIndersciencePublications, John WileyandSons, 1999.

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

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

MappingofCOSandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**1**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**2**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

ADVANCEDCOMPUTERARCHITECTURE			
CourseCode	22LAC335	CIEMarks	50
TeachingHours/Week(L:P: SDA)	3:0:0	SEE Marks	50
TotalHoursofPedagogy	40 HoursTheory	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives: Thiscoursewill enablestudents:

1. Understandthebasicconceptsforparallelprocessing
2. Analyzeprogrampartitioningandflowmechanisms
3. Applypipeliningconceptfortheperformanceevaluation
4. Learntheadvancedprocessorarchitecturesforsuitableapplications
5. UnderstandparallelProgramming

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activitybased method,Seminar

MODULE-1

ParallelComputerModels:TheStateofComputing,Multiprocessorsandmulticomputers,MultivectorandSIMD computers.

ProgramandNetworkProperties:Conditionsofparallelism,ProgramPartitioning&Scheduling,ProgramFlowMechanisms.

MODULE-2

PrinciplesofScalablePerformance:PerformanceMetricsandMeasures,ParallelProcessingApplications,SpeedupPerformance Laws, ScalabilityAnalysis andApproaches.

Processors&MemoryHierarchy:Advancedprocessortechnology,SuperScalars&VectorProcessors,MemoryHierarchyTechnology, VirtualMemoryTechnology.

MODULE-3

Bus,CacheandSharedMemory:BusSystems,CacheMemoryOrganizations,SharedMemoryOrganizations,Sequential&WeakConsistencyModel.

Pipelining&SuperscalarTechnologies:LinearPipelineProcessors,NonlinearPipelineProcessors,InstructionPipeline Design, ArithmeticPipeline Design,SuperscalarPipeline Design.

MODULE4
Multivector&SIMDComputers:VectorProcessingprinciples,MultivectorMultiprocessors,CompoundVectorProcessing, SIMDComputerOrganization. **Scalable,MultithreadedandDataFlowComputers**:LatencyHidingTechniques,PrinciplesofMultithreading,FineGrainMultiComputers,ScalableandMultithreadedArchitectures,Data Flow andHybrid Architectures.
MODULE5
ParallelModels,LanguagesandCompilers:ParallelProgrammingModels,ParallelLanguages&Compilers, Dependence Analysis and Data Arrays, Code Optimization and Scheduling, Loop ParallelizationandPipelining. **Parallel Program Development and Environments**: Parallel Programming Environments, SynchronizationandMultiProcessor Modes, Shared VariableProgramStructures.
AssessmentDetails(bothCIEandSEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% ofthe maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements andearned 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) takentogether. **ContinuousInternalEvaluation:** • ThreeUnitTestseach of**20Marks** • Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COsand POs Thesumofthreetests,twoassignments/skillDevelopment Activities,will bescaleddownto50marks. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per theoutcomedefinedfor the course.** **SemesterEndExamination:** 1.TheSEEquestionpaper will besetfor100marksandthemarks scoredwill beproportionatelyreducedto 50.

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4. Eachfull questionwillhaveasub-questioncoveringallthetopics underamodule.

Thestudents willhave toanswerfivefullquestions,selectingone fullquestion fromeach module.

Textbook:

'AdvancedComputerArchitecture:Parallelism,Scalability,Programmability',KaiHwang&NarendraJotwani,McGraw HillEducation, ISBN:978-93-392-2092-1,3rdEdition,2016

ReferenceBooks:

1. 'ComputerArchitecture,PipelinedandParallel ProcessorDesign',M.J.Flynn,NarosaPublishing,2002.
2. 'Parallel programminginCwithMPIandOpenMP',MichaelJQuinn,TataMcGrawHill, 2013.

. 'AnIntroductiontoParallelComputing:DesignandAnalysisofAlgorithms',AnanthGrama,Pearson,2ndEdition, 2004.

Courseoutcome(CourseSkill Set)

At theend ofthe coursethestudent willbeable to:

- Understand the basic concepts for parallel processing
- Analyze program partitioning and flow mechanisms
- Apply pipelining concept for the performance evaluation
- Learn the advanced processor architectures for suitable applications
- Understand parallel Programming

MappingofCOSandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	2	1	-	-	-	-	-	2
CO2	1	1	1	2	1	1	-	-	-	-	-	2
CO3	2	1	2	1	1	1	-	-	-	-	-	2
CO4	1	1	1	2	1	1	-	-	-	-	-	1
CO5	1	1	2	1	1	1	-	-	-	-	-	1