RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road
Bengaluru – 560059

Scheme and Syllabus of I & II Semester

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
DIGITAL COMMUNICATION ENGINEERING

DEPARTMENT OF

TELECOMMUNICATION ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the Global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

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(Autonomous System of 2018 Scheme)

Master of Technology (M. Tech)
in
DIGITAL COMMUNICATION ENGINEERING

DEPARTMENT OF

TELECOMMUNICATION ENGINEERING

DEPARTMENT OF
TELECOMMUNICATION ENGINEERING

VISION

Imparting quality education in electronics and telecommunication engineering through focus on fundamentals, research and innovation for sustainable development.

MISSION

1. Provide comprehensive education that prepares students to contribute effectively to the profession and society in the field of Telecommunication.
2. Create state-of-the–art infrastructure to integrate a culture of research with a focus on Telecommunication Engineering Education.
3. Encourage students to be innovators to meet local and global needs with ethical practice.
4. Create an environment for faculty to carry out research and contribute in their field of specialization, leading to Center of Excellence with focus on affordable innovation.
5. Establish a strong and wide base linkage with industries, R&D organization and academic Institutions.

PROGRAMME OUTCOMES (PO)

M. Tech in Digital Communication Engineering graduates will be able to:

PO1: Acquire in-depth knowledge of Digital Communication Engineering with an ability to analyse, synthesize, evaluate existing and new technologies.

PO2: Learn and apply modern engineering tools to solve complex engineering problems.

PO3: Engage in life-long learning independently, to contribute for multidisciplinary research work.

PO4: Independently carry out research /investigation and development work to solve practical problems.

PO5: Write and present a substantial technical report/document.

PO6: Demonstrate a degree of mastery over the area Digital Communication Engineering. The mastery would be at a level higher than the requirements in the appropriate bachelor program.

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Processing Signal & Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

CONTENTS

RV COLLEGE OF ENGINEERING®, BENGALURU - 560059
(Autonomous Institution Affiliated to VTU, Belagavi)

DEPARTMENT OF TELECOMMUNICATION ENGINEERING

M. Tech in DIGITAL COMMUNICATION ENGINEERING

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1.	18MAT11B	Probability Theory And Linear Algebra	MAT	4	0	0	**4**
2.	18MDC12	Advanced Digital Communication	TE	3	1	1	**5**
3.	18MDC13	DSP for Communication	TE	3	1	1	**5**
4.	18HSS14	Professional Skills Development*	HSS	0	0	0	**0**
5.	18MDC1AX	Elective –A	TE	3	1	0	**4**
6.	18MDC1BX	Elective – B	TE	4	0	0	**4**
Total number of Credits				**17**	**3**	**2**	**22**
Total Number of Hours/Week				**17**	**6**	**4**	**27**

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1.	18MDC21	Optical Communication & Networks	TE	3	1	1	05
2.	18MRM22	Antenna Theory & design	TE	3	1	0	04
3.	18IEM23	Research Methodology	IEM	3	0	0	03
4.	18MDC24	Minor Project	TE	0	0	2	02
5.	18MDC2CX	Elective-C	TE	4	0	0	04
6.	18MDC2DX	Elective-D	TE	4	0	0	04
7.	18MDC2GX	Global Elective – G	Respective BoS	3	0	0	03
Total number of Credits				**20**	**2**	**3**	**25**
Total Number of Hours/Week				**20**	**4**	**6**	**30**

SEMESTER : II		
GROUP A: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MDC1A1	RF circuits & systems
2.	18MDC1A2	Real Time Embedded System
3.	18MDC1A3	Object Oriented Programming
GROUP B: PROFESSIONAL ELECTIVES		
1.	18MDC1B1	Detection & Estimation Theory
2.	18MDC1B2	Artificial Neural Network
3.	18MDC1B3	Wireless Sensor Networks
SEMESTER : II		
GROUP C: PROFESSIONAL ELECTIVES		
1.	18MRM2C1	Modern Antenna
2.	18MCS2C2	Machine learning
3.	18MDC2C3	Error Control Coding
GROUP D: PROFESSIONAL ELECTIVES		
1.	18MDC2D1	Multimedia Communication
2.	18MDC2D2	Advanced VLSI
3.	18MDC2D3	Broad Band Networks

GROUP G: GLOBAL ELECTIVES				
Sl No.	**Course Code**	**Host Dept.**	**Course Title**	**Credits**
1.	18CS2G01	CS	Business Analytics	03
2.	18CV2G02	CV	Industrial & Occupational Health and Safety	03
3.	18IM2G03	IM	Modeling using Linear Programming	03
4.	18IM2G04	IM	Project Management	03
5.	18CH2G05	CH	Energy Management	03
6.	18ME2G06	ME	Industry 4.0	03
7.	18ME2G07	ME	Advanced Materials	03
8.	18CHY2G08	CHY	Composite Materials Science and Engineering	03
9.	18PHY2G09	PHY	Physics of Materials	03
10.	18MAT2G10	MAT	Advanced Statistical Methods	03

SEMESTER : I						
PROBABILITY THEORY AND LINEAR ALGEBRA (Common to MCN, MCE, MCS, MIT, MSE, MRM, MDC)						
Course Code	**:**	**18MAT11B**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

Matrices and Vector spaces:

Geometry of system of linear equations, vector spaces and subspaces, linear independence, basis and dimension, four fundamental subspaces, Rank-Nullity theorem(without proof), linear transformations.

Unit – II	**10 Hrs**

Orthogonality and Projections of vectors:

Orthogonal Vectors and subspaces, projections and least squares, orthogonal bases and Gram- Schmidt orthogonalization, Computation of Eigen values and Eigen vectors, diagonalization of a matrix, Singular Value Decomposition.

Unit – III	**11 Hrs**

Random Variables:

Definition of random variables, continuous and discrete random variables, Cumulative distribution Function, probability density and mass functions, properties, Expectation, Moments, Central moments, Characteristic functions.

Unit – IV	**11 Hrs**

Discrete and Continuous Distributions:

Binomial, Poisson, Exponential, Gaussian distributions.

Multiple Random variables:

Joint PMFs and PDFs, Marginal density function, Statistical Independence, Correlation and Covariance functions, Transformation of random variables, Central limit theorem (statement only).

Unit – V	**10 Hrs**

Random Processes:

Introduction, Classification of Random Processes, Stationary and Independence, Auto correlation function and properties, Cross correlation, Cross covariance functions. Markov processes, Calculating transition and state probability in Markov chain.

Course Outcomes

After going through this course the student will be able to:

CO1	Demonstrate the understanding of fundamentals of matrix theory, probability theory and random process.
CO2	Analyze and solve problems on matrix analysis, probability distributions and joint distributions.
CO3	Apply the properties of auto correlation function, rank, diagonalization of matrix, verify Rank - Nullity theorem and moments.
CO4	Estimate Orthogonality of vector spaces, Cumulative distribution function and characteristic function. Recognize problems which involve these concepts in Engineering applications.

Reference Books

1	Probability, Statistics and Random Processes, T. Veerarajan, 3rd Edition, 2008, Tata McGraw Hill Education Private Limited, ISBN:978-0-07-066925-3.
2	Probability and Random Processes With Applications to Signal Processing and Communications, Scott. L. Miller and Donald. G. Childers, 2nd Edition, 2012, Elsevier Academic Press, ISBN 9780121726515.
3	Linear Algebra and its Applications, Gilbert Strang, 4th Edition, 2006, Cengage Learning, ISBN 97809802327.
4	Schaum's Outline of Linear Algebra, Seymour Lipschutz and Marc Lipson, 5th Edition, 2012, McGraw Hill Education, ISBN-9780071794565.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
ADVANCED DIGITAL COMMUNICATION (Theory and Practice)						
Course Code	**:**	**18MDC12**		**CIE Marks**	**:**	**100+50**
Credits L:T:P	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**39L+26T+26P**		**SEE Duration**	**:**	**3 + 3 Hrs**
Unit – I						**08Hrs**
Digital Modulation Techniques: Digital modulation formats, Coherent binary modulation techniques, Coherent quadrature – modulation techniques, Non-coherent binary modulation techniques, Comparison of binary and quaternary modulation techniques, M-ray modulation techniques, Power spectra, Bandwidth efficiency.						
Unit – II						**08Hrs**
Coding Techniques: Convolutional encoding, Convolutional encoder representation, Formulation of the convolutional decoding problem, Properties of convolutional codes: Distance property of convolutional codes, Systematic and nonsystematic convolutional codes, Performance Bounds for Convolutional codes, Coding gain.						
Unit – III						**08Hrs**
Linear Equalization: Linear equalization, Decision -feedback equalization, Reduced complexity ML detectors.						
Unit – IV						**08Hrs**
Adaptive Equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Recursive least square algorithms for adaptive equalization.						
Unit – V						**07Hrs**
Spread Spectrum Signals for Digital Communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS.						
Lab Component						
The students are expected to design, use modern tools to develop experiments to study the performance and infer changes required in their design for:						
MASK, MFSK, MPSK, QPSK, MSK, GMSK and M-arry modulation techniques. Students are expected to apply Convolution coding,. Linear Equalizers and adaptive equalizers.						
Study the performance of Spread spectrum techniques, multipath diversity and Multicarrier Modulation techniques.						
Course Outcomes **After going through this course the student will be able to:**						
CO1	Explain merits and demerits of different modulation techniques & coding techniques, spread spectrum signals and channel behaviours.					
CO2	Analyze various modulation, equalization, diversity and coding techniques for communication systems.					
CO3	Compare performance of different types of modulation on different wireless applications.					
CO4	Design and demonstrate various modulation/coding equalization techniques and measure their performance.					
Reference Books						
1.	Digital Communication, Simon Haykin, 2013, Reprint, Wiley, ISBN: 0471647357, 9780471647355.					
2.	Digital Communications - Fundamentals and Applications, Bernard Sklar,, 2nd Edition, 2014, Pearson Education (Asia) Pvt. Ltd, ISBN: 1292026065, 9781292026060.					
3.	Digital Communications, John G. Proakis, 5th Edition, 2008, McGraw Hill, ISBN 978-0-07-295716-7.					
4.	Principles of Digital Communication, Robert G. Gallager, 1st Edition,2008, Cambridge University Press, ISBN-13: 978-0521879071.					

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : I						
DSP FOR COMMUNICATION (Theory and Practice)						
Course Code	**:**	**18MDC13**		**CIE Marks**	**:**	**100+50**
Credits L:T:P	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**39L+26T+26P**		**SEE Duration**	**:**	**3 + 3 Hrs**

Unit – I	**08 Hrs**
Design of Digital Filters: General Considerations, Design of FIR filters, Design of IIR filters from analog Filters, Frequency Transformation.	
Unit – II	**08 Hrs**
Multi rate Digital Signal Processing: Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a Rational Factor I/D. Implementation of sampling Rate Conversion, Multistage implementation of sampling rate conversion, Sampling rate conversion by an Arbitrary Factor.	
Unit – III	**08 Hrs**
Applications of Multi rate Digital Signal Processing: Digital Filter Banks, Two-Channel Quadrature Mirror Filter Bank, M-channel QMF Bank. Oversampling and Analog-to-Digital Conversion Resolution, Sigma-Delta Modulation Analog to Digital Conversion and CD Player.	
Unit – IV	**08 Hrs**
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, Levinson – Durdin algorithm, properties of the Linear Prediction-Error Filters, Wiener Filters for filters for filtering and prediction	
Unit – V	**07 Hrs**
Adaptive Filters: Applications of Adaptive filters, Adaptive Direct-Form FIR Filters- The LMS algorithm, Adaptive Direct Form Filters- RLS algorithm.	

Lab Component
The students are expected to design, use modern tools to develop experiments to study the performance and infer changes required in their design for:
Design and simulation of IIR and FIR filters.
Simulation of image processing using DCT & IDCT, DFT and IDFT and Up and Down sampling of signals and sequences.

Course Outcomes **After going through this course the student will be able to:**	
CO1	Apply design techniques for FIR and IIR filters.
CO2	Evaluate various linear filters and adaptive filters for multirate signal processing.
CO3	Design and demonstrate various filters and sampling rate conversions.
CO4	Design and demonstrate various Processing systems.

Reference Books:	
1.	Digital Signal Processing, John G. Proakis and Manolakis, 4th Edition, 2007, Prentice Hall, ISBN-978-8131710005.
2.	Digital Signal Processing Fundamentals and Applications, Li Tan, 2nd Edition, 2008, Academic Press, India, ISBN-13: 978-0124158931.
3.	Modern Digital Signal Processing, Robert O Cristi, 1st Edition,2003, Cengage publishers India, ISBN-10: 0534400957.
4.	Digital Signal Processing: A computer based Approach, S K Mitra, 3rd Edition, 2007 Tata Mcgraw Hill, India, ISBN-10: 0071244670.

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

RV College of Engineering®

SEMESTER : I

PROFESSIONAL SKILL DEVELOPMENT

(Common to all Programs)

Course Code	**:**	**18HSS14**	**CIE Marks**	**:**	**50**
Credits L: T: P	**:**	**0:0:0**	**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**24 L**			

Unit – I **03 Hrs**

Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis.

Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.

Unit – II **08 Hrs**

Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities.

Reasoning – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet.

b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification.

Analytical Reasoning - Single & Multiple comparisons, Linear Sequencing.

Logical Aptitude - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions.

Verbal Analogies/Aptitude – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving

Unit – III **03 Hrs**

Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette-Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews

Unit – IV **03 Hrs**

Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion(Assertiveness) and presentation skills

Unit – V **07 Hrs**

Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited).

Leadership Skills: Ethics and Integrity, Goal Setting, leadership ability.

Course Outcomes

After going through this course the student will be able to:

CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books

1. The 7 Habits of Highly Effective People, Stephen R Covey, 2004 Edition, Free Press, ISBN: 0743272455
2. How to win friends and influence people, Dale Carnegie, 1st Edition, 2016, General Press, ISBN: 9789380914787
3. Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4. Ethnus, Aptimithra: Best Aptitude Book, 2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Phase	Activity
I	After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).

FINAL CIE COMPUTATION

Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.

SEMESTER : I						
RF CIRCUITS AND SYSTEMS (Professional Elective-A1)						
Course Code	**:**	**18MDC1A1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**07Hrs**
Introduction – Reasons for using RF/ Microwaves, Applications, RF and Microwave (MW) Circuit Design. **RF Electronics Concepts –** Introduction to Components basics, Analysis of a Simple Circuit Phasor Domain, RF Impedance Matching.						
Unit – II						**08Hrs**
Fundamentals of Wave Propagation: Properties of Waves, Transmission Media. **Circuit Representations of Two-Port RF/MW Networks** - Low-Frequency Parameters, High-Frequency parameters, Formulation of S-parameters, Properties, Transmission Matrix, and Generalized S-parameters.						
Unit – III						**08Hrs**
Passive circuit design: Introduction, Smith chart and Applications **Design of matching networks:** Definition of Impedance Matching, Matching using lumped and distributed elements						
Unit – IV						**08Hrs**
Basic consideration in active networks: Stability Consideration in Active Networks, Gain Considerations in Amplifiers, Noise Considerations in Active Networks.						
Unit – V						**08Hrs**
Active Networks: Linear and Non-Linear Design: Introduction, Types of Amplifiers, Small Signal Amplifiers, Design of different types of Amplifiers. **Oscillators:** Introduction, Oscillator Vs Amplifier Design, Oscillation Conditions, Design of Transistor Oscillators.						
Course Outcomes **After going through this course the student will be able to:**						
CO1	Describe RF Circuits, impedance matching & working of small & large signal microwave amplifier.					
CO2	Calculate the RF circuits parameters like S-Parameter, SNR and VSWR and impedance transformation and also impedance matching.					
CO3	Analyze the performance of RF Circuits in terms of Gain, Stability and Noise.					
CO4	Design various active and passive networks with linear and non-linear design considerations.					
Reference Books:						
1.	RF and Microwave Electronics Illustrated, Matthew M. Radmanesh, 1st edition, 2004, Pearson Education, ISBN-978-81-775-8401-1.					
2.	RF Circuit Design Theory and Applications, Reinhold Ludwig, and Pavel Bretchko, 2004, Pearson Education edition, ISBN: 978-81-317-6218-9.					
3.	Microwave Engineering, D. Pozar, 2005, John Wiley & Sons, New York.: ISBN: 978-0-470-63155-3.					
4.	Microwave Solid State Circuit Design, Inder Bahl and Prakash Bhartia, , 2nd edition, Wiley India edition, ISBN: 978-0471207559.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
REAL-TIME EMBEDDED SYSTEM (Professional Elective-A2)						
Course Code	**:**	**18MDC1A2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**03Hrs**

Unit – I	**08Hrs**
Hardware Fundamentals for software Engineer: Examples of Embedded Systems, Terminology, Gates, A few other basic considerations, Timing Diagram, Memory. **Advanced Hardware Fundamentals:** Microprocessors, Buses, Direct Memory Access, Interrupts, Other Common Parts, Built-Ins on the Microprocessor.	
Unit – II	**08Hrs**
Interrupts: Microprocessor Architecture, Interrupts Basics, Shared Data Problem, Interrupt Latency. **Survey of Software Architectures:** Round- Robin, Round-Robin with Interrupts, Function-Queue-Scheduling Architecture, Real-Time Operating System Architecture, Selecting Architecture.	
Unit – III	**08Hrs**
Introduction to Real-Time Operating System: Task and Task States, Tasks and Data, Semaphores and Shared Data. **More Operating System Services:** Message Queues, Mail Boxes and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment	
Unit – IV	**08Hrs**
Basic Design using a Real-Time Operating System: Overview, Principles, An Example, Encapsulating Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory Space, Saving Power.	
Unit – V	**07Hrs**
Embedded Software Development tools: Host and Target Machines, Linker/ Locators for Embedded Software, Getting Embedded Software into the Target System.	

Course Outcomes
After going through this course the student will be able to:

CO1	Analyze the hard ware and software fundamental requirements to build an embedded system.
CO2	Analyze the concepts of Microprocessor and built in features for design of Embedded Systems.
CO3	Apply the concepts of Real-Time Operating Systems in Embedded system design.
CO4	Apply the embedded software development tools for design, development and debugging of various embedded systems.

Reference Books

1.	An Embedded Software Primer, David E. Simon, Pearson Education, 2002, ISBN: 81-7808-045-1.
2.	Embedded Systems, Architecture programming and Design, Raj Kamal, 3rd Edition, 2017, McGraw Hill Education, ISBN:10: 9789332901490.
3.	Real-Time Systems, Jane W. Liu, Pearson Education, 2001, ISBN: 9788177585759.
4.	Real-Time Systems: Theory and Practice, Rajib Mall, Pearson Education, 2008. ISBN: 9788131700693.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
OBJECT ORIENTED PROGRAMMING CONCEPTS (Professional Elective-A3)						
Course Code	**:**	**18MDC1A3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**08Hrs**
Overview of C++: Principles of object-objective Programming, Tokens, Expressions and control structures, Functions in C++, Classes and Objects, Destructors and Constructors.						
Unit – II						**08Hrs**
Concepts of Object Oriented Programming: Operator Overloading, Inheritance: Extending Classes, Pointers, Virtual functions and polymorphism, Exception handling, Class Templates.						
Unit – III						**08Hrs**
Data Structures - Lists: Linear lists, Linked list, Matrices - Special Matrices and Sparse Matrices.						
Unit – IV						**08Hrs**
Data Structures - Stacks, Queues: Stacks using Linear, Link List , Applications - Towers of Hanoi, Switch Box Routing Queues using Linear, Link List , Applications - Rail Road Car Arrangement, Image Component Labeling.						
Unit – V						**07Hrs**
Data Structures -Trees, Graphs: Hash Tables, Binary Trees and Graphs (Representation, Class Definitions).						
Course Outcomes **After going through this course the student will be able to:**						
CO1	Exhibit program design and implementation competence through the choice of appropriate object oriented concept and data structures.					
CO2	Design and analyze the applications using Object Oriented Approach and data structures.					
CO3	Envision the solutions for real-time problems using Object Oriented concepts and data structures.					
CO4	Implement data Structures using C++.					
Reference Books:						
1.	Object Oriented Programming with C++, E. Balaguruswamy, 4th edition, 2012, McGraw Hill,Company Ltd.,ISBN: 0070593620.					
2.	Data Structures, Algorithms, and Applications in C++, Sartaj Sahni, 2000, McGraw Hill, ISBN: 0-929306-33-3.					
3.	Big C++, Cay S. Horstmann, Timothy Budd, Wiley India (P.) Ltd, 1st Edition, 2009, ISBN: 9788126509201.					
4.	The Complete Reference C++, Herbert Schildt, McGrawHill, 4th Edition, 2011, ISBN: 9780070532465.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
DETECTION AND ESTIMATION THEORY (Group B: Professional Elective)						
Course Code	**:**	**18MDC1B1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**10Hrs**
Introduction: Detection theory in Signal Processing, Detection problem, Mathematical Detection Problem, Hierarchy of Detection Problems, Role of Asymptotic. **Introduction to PDFs:** Fundamental Probability Density Functions and Properties, Quadratic Forms of Gaussian Random Variables, Asymptotic Gaussian PDF. **Statistical Decision Theory-I:** Neyman-Pearson Theorem, Receiver Operating Characteristics, Irrelevant Data, Minimum Probability of Error, Bayes Risk, Multiple Hypothesis Testing.						
Unit – II						**10Hrs**
Deterministic Signals: Introduction, Matched Filters, Generalized Matched Filters, Multiple Signals, Linear Models, Signal Processing Examples.						
Unit – III						**10Hrs**
Random Signals: Introduction, Estimator- Correlator, Linear Model, Estimator – Correlate for Large Data Records, General Gaussian Detection, Signal Processing Examples.						
Unit – IV						**12Hrs**
Statistical Decision Theory-II: Introduction, Composite Hypothesis Testing, Composite Hypothesis Testing Approaches, Performance of GLRT for Large Data Records, Equivalent Large Data Records Tests, Locally Most Powerful Detectors, Multiple Hypothesis Testing. **Deterministic signals with Unknown Parameters:** Signal Modeling and Detection Performance, Unknown Amplitude, Sinusoidal Detection.						
Unit – V						**10Hrs**
Estimation: Estimation in Signal Processing, The Mathematical Estimation Problem, Assessing Estimator Performance. **Minimum Variance Unbiased Estimation:** Unbiased Estimators Minimum Variance Criterion, Existence of the minimum Variance Unbiased Estimator, Finding the Minimum Variance Unbiased Estimator, definition and properties of Linear Models with Examples. Cramer Rao Lower Bound.						
Course Outcomes **After going through this course the student will be able to:**						
CO1	Study of different PDFs, various signals, Detection Problem and their behavior in different detection and estimation applications.					
CO2	Design of Matched filters for binary & M-ary hypotheses with performance.					
CO3	Analyze Estimator- Correlator, Locally Most Powerful Detectors with Multiple Hypothesis Testing.					
CO4	Design and analysis of minimum Variance Unbiased Estimator.					
Reference Books:						
1.	Fundamentals of Statistical Signal Processing- Detection Theory, Steven M. Kay, Volume II, 1998, Prentice Hall, USA, ISBN-9788131729007.					
2.	Fundamentals of Statistical Signal Processing- Estimation Theory, Steven M. Kay, Volume I, 1998, Prentice Hall, USA, ISBN-9788131728994.					
3.	Introduction to Statistical Signal Processing with Applications, M.D. Srinath, P.K. Rajasekaran and R. Viswanathan,2003, Pearson Education (Asia) Pte. Ltd. /Prentice Hall of India, ISBN-13: 978-0131252950.					
4.	Detection, Estimation and Modulation Theory: Detection, Estimation, and Linear Modulation Theory, Harry L. Van Trees, 2001 John Wiley & Sons, Inc., ISBN:9780471221081.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
ARTIFICIAL NEURAL NETWORK (Group B: Professional Elective)						
Course Code	**:**	**18MDC1B2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**10Hrs**
Statistical Pattern Recognition: classification and regression, pre processing and feature extraction, curse of dimensionality, polynomial curve fitting, model complexity, multivariate nonlinear functions, bayes theorem, minimizing risk **Probability Density Estimation:** Parametric methods, maximum likelihood, Bayesian inference, sequential parameter estimation, non parametric methods, Mixture models.						
Unit – II						**10Hrs**
Single layer networks: Linear discriminant functions, Linear separability, Generalized linear discriminats, least squares techniques, the perceptron, fishers linear discriminant						
Unit – III						**10Hrs**
Multilayer perceptron: Feed-forward network mappings, threshold units sigmoidal units, weight space symmetries, higher order networks, projection pursuit regression, Kolmigorov's theorem, error back propapation, jacobian matrix, hessian matrix						
Unit – IV						**12Hrs**
Radial Basis Functions: Exact interpolation, Radial basis function networks, network training, regularization theory, noisy interpolation theory, relation to kernel regression, radial basis functions networks for classification, compression with multi layer perceptron, basis functions optimizations, supervised learning. **Error functions:** sum of squares error, minkoski error, input dependent variance, modelling conditions distributions estimating posterior probabilities, sum of squares for classification, cross entropy for two classes, multiple independent attributes, cross-entropy for multiple classes, entropy, general conditions.						
Unit – V						**10Hrs**
Pre-processing and Feature Extraction: pre-processing and post-processing, input normalization and encoding, missing data, time series predication, feature selection, principal component analysis, Invariances and prior knowledge. **Learning and Generalization:** Bias and variance, Regularization, training with noise, soft weight sharing, growing and pruning algorithms committees of networks, mixtures of experts, model order selection, vapnik-chervonenkis dimension.						
Course Outcomes **After going through this course the student will be able to:**						
CO1	Understand the basics of probability, probability density estimation, and neural network.					
CO2	Apply the statistical techniques in pattern recognition problems					
CO3	Analyze the neural network techniques, feature extraction techniques, pre and post processing techniques.					
CO4	Evaluate the performance of neural network for a given problem.					
Reference Books:						
1.	Neural Networks and Pattern Recognition, C.M.Bishop, 2003, Oxford University Press (Indian Edition), ISBN-13: 978-0198538646.					
2.	Pattern Classification, R.O.Duda, P.E.Hart and D.G.Stork, 2002, John Wiley, ISBN-13: 978-8126511167.					
3.	Neural Networks and Learning Machines, Simon Haykin, 2008, Pearson, ISBN-10: 0131293761, ISBN-13: 978-0131293762.					
4.	Neural Networks - A Classroom Approach, Satish Kumar, 2017, McGraw Hill Education, ISBN-10: 1259006166, ISBN-13: 978-1259006166.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
WIRELESS SENSOR NETWORKS (Group B: Professional Elective)						
Course Code	**:**	**18MDC1B3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**10Hrs**
Introduction, Overview and Applications of Wireless Sensor Networks Introduction: Background of Sensor Network Technology, Basic overview of the Technology: Basic Sensor Network Architectural Elements, Applications of Wireless Sensor Networks: Introduction, Background, Range of Applications, Examples of Category 2 WSN Applications, Examples of Category 1 WSN Applications, Another Taxonomy of WSN Technology.						
Unit – II						**10Hrs**
Basic Wireless Sensor Technology: Introduction, Sensor Node Technology, Sensor Taxonomy, WN Operating Environment, WN Trends. **MAC and Routing Protocols for Wireless Sensor Networks:** Introduction, Background, Fundamentals of MAC Protocols, MAC Protocols for WSNs, Sensor-MAC case Study, IEEE 802.15.4 LR-WPANs Standard Case Study.						
Unit – III						**10Hrs**
Routing Protocols for Wireless Sensor Networks: Introduction, Background, Data Dissemination and Gathering, Routing Challenges and Design Issues in WSNs, Routing Strategies in WSNs.						
Unit – IV						**12Hrs**
Transport Control and Middleware for Wireless Sensor Networks : Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols..						
Unit – V						**10Hrs**
Middleware for Wireless Sensor Networks: Introduction, WSN Middleware Principles, Middleware Architecture, Existing Middleware: MiLAN (Middleware Linking Applications and Networks), IrisNet (Internet-Scale Resource-Intensive Sensor Networks Services).						
Course Outcomes **After going through this course the student will be able to:**						
CO1	Describe the type of sensor networks, protocols and applications of WSN.					
CO2	Analyze the design issues of Transport,Network, MAC and Physical layers of WSN.					
CO3	Create architecture and Identify need and selection of protocols for WSN.					
CO4	Explore various middleware and transport protocols that exist for sensor networks.					
Reference Books:						
1.	Wireless Sensor Networks: Technology, Protocols and Applications, Kazem Sohraby, Daniel Minoli, Taieb Znati, 2nd Edition (Indian), 2014, WILEY, ISBN 978-0-471-74300-2.					
2.	Wireless Sensor Networks, Ian F. Akyildiz, Mehmet Can Vuran,2010,Wiley, ISBN-13: 978-0470036013.					
3.	Wireless SensorNetworks- An Information Processing Approach, Feng Zhao & Leonidas J. Guibas, 2007, Elsevier, ISBN-1558609148, 9781558609143.					
4.	Fundamentals of Wireless Sensor Networks Theory and Practice, Waltenegus Dargie and Christin Poellabauer, 1st EditionJohn Wiley 2010, ISBN 978-0-470-99765-9.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
OPTICAL COMMUNICATION AND NETWORKS (Theory and Practice)						
Course Code	**:**	**18MDC21**		**CIE Marks**	**:**	**100+50**
Credits L:T:P	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**39L+26T+26P**		**SEE Duration**	**:**	**3+3Hrs**

Unit – I	**07Hrs**
Introduction Introduction to optical fibers, Propagation of signals in optical fiber, Different losses, Effective Length & Area, Stimulated Brillouin Scattering, Stimulated Raman Scattering, Solitons, Propagation in a Non linear medium, Self phase modulation, SPM – induced Chirp for Gaussian pulses, Cross phase Modulation, Optical sources, Detectors.	
Unit – II	**08Hrs**
Optical Components: Couplers, Isolators, Circulators, Multiplexers, filters, Gratings, Interferometers, Amplifiers. **Modulation & Demodulation:** Sequential Decoding and Feedback Decoding, Formats, Ideal Receivers, Practical detection receivers, Optical preamplifier, Noise Considerations, Bit error rates, Coherent detection, Timing Recovery.	
Unit – III	**08Hrs**
Transmission System Engineering: System model, Power penalty, Transmitter, Receiver, Different Optical Amplifiers, Dispersion. **Optical networks:** Client layers of the optical layer, SONET/SDH, Multiplexing, layers, Frame Structure, ATM functions, Adaptation layers, Quality of service and flow, ESCON, HIPPI	
Unit – IV	**08Hrs**
WDM network elements: Optical line terminal, Optical line amplifiers, Optical cross connectors, WDM network Design, Cost trade off, statistical dimensioning model, LTD and RWA problems, Routing and wavelength assignment, Wavelength conversion.	
Unit – V	**08Hrs**
Control and Management: Network management functions, Management frame work, Information model, Management protocols, Layers within optical layer performance and fault management, Impact of transparency, BER measurement, Optical trace, Alarm and configuration management.	
Lab Component	
The students are expected to design, use modern tools to develop experiments to study the performance and infer changes required in their design for:	
Characterization of optical fibers, sources and detectors.	
Analysis of Analog, Digital link, TDM, FDM using fiber and optical fiber voice link.	
Study of WDM components, SONETS and topology using Tejas Lab Setup.	
Simulation of WDM network elements using optisystem.	

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Justify the use of optical components, transmission techniques and network management concepts.
CO2	Analyze the performance characteristics of transmitting and receiving components and systems.
CO3	Create a modulation scheme, topology for WDM network and apply network management functions.
CO4	Develop and demonstrate techniques used in optical communication links.

Reference Books:

1.	Optical Networks, Rajiv Ramswami, N Sivaranjan, 3rd Edition, 2009, M Kauffman Publishers, ISBN-10: 9780123740922.
2.	Optical Fiber Communication, Gerd Keiser, 4th Edition, 2011, McGraw Hill, ISBN-10: 1259006875.
3.	Fiber Optics Communication Systems, G P Agarwal, 3rd Edition, 2002, John Wiley and Sons, New York, ISBN-978-0470505113.
4.	Optical Fiber Communications, John M Senoir, 3rd Edition, 2009, Pearson Education, ISBN-13: 978-0-13-032681.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

SEMESTER : II						
ANTENNA THEORY AND DESIGN (Theory)						
Course Code	**:**	**18MRM22**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**07Hrs**
Introduction: Antenna Radiation mechanism, Fundamental Concepts of antenna parameters. **Dipoles and Loops:** Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.						
Unit – II						**08Hrs**
Arrays: Two Element Array, N-Element Linear Array - Uniform Amplitude and Spacing, Directivity, Non Uniform Amplitude Array Factor: Binomial Array, Dolph -Tschebyscheff Array, Planar Array.						
Unit – III						**08Hrs**
Broad Band Antennas: Helical Antennas, Design Concepts, Frequency Independent Antennas - Equiangular Spiral Antennas, Log Periodic Antennas, Design Concepts. **Microstrip Antennas:** Basic Characteristics, Feeding Methods, Rectangular Patch Transmission Line Model, Design Concepts.						
Unit – IV						**08Hrs**
Aperture Antennas: Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, **Horn and Reflector Antennas:** Radiation from sectoral and pyramidal horns, design concepts, Radiation from parabolic reflector and cassegrain antennas.						
Unit – V						**08Hrs**
Antenna Synthesis: Synthesis of antenna arrays using Fourier transform method, Woodward-Lawson method. **Method of Moments**-Solution to Pocklington Integral Equation, MOM Method, Basis Function and Sources.						
Course Outcomes **After successful completion of this course the student will be able to:**						
CO1	Elucidate the basic principles of radiation for various antennas and antenna parameters					
CO2	Analyze the characteristics of various Antennas and solve radiation problem using MOM method.					
CO3	Design or synthesize various antennas.					
CO4	Compute, compare and simulate various Antennas.					
Reference Books						
1.	Antenna Theory Analysis and Design, C. A. Balanis. 2nd Edition, 2004, John Wiley, ISBN-9780471592686.					
2.	Antenna Theory and Design, Stutzman and Thiele, 2nd Edition, 2013, John Wiley and Sons Inc., ISBN- 978-0-470-57664-9.					
3.	Antennas and Wave Propagation, John D Kraus, Ronald J Marhefka and Ahmad S Khan, 4th Edition 2010, Tata McGraw Hill, ISBN- 987-0-07-067155-3.					
4.	Modern Antenna Design, THOMAS A. MILLIGAN, 2nd Edition 2005, John Wiley and Sons Inc. , ISBN-978-0-471-45776-3.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II
RESEARCH METHODOLOGY
(Common to all programs)

Course Code	**:**	**18IM23**	**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**	**SEE Marks**	**:**	**100**
Hours	**:**	**39L**	**SEE Duration**	**:**	**3 Hrs**

Unit – I | **08 Hrs**

Overview of Research

Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.

Unit – II | **08 Hrs**

Data and data collection

Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.

Sampling Methods: Probability sampling and Non-probability sampling

Unit – III | **08 Hrs**

Processing and analysis of Data

Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools

Unit – IV | **08 Hrs**

Advanced statistical analyses

Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.

Unit-V | **07 Hrs**

Essentials of Report writing and Ethical issues

Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism

Case studies: Discussion of case studies specific to the domain area of specialization

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

Reference Books

1	Research Methodology Methods and techniques by, Kothari C.R., New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2	Management Research Methodology, Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	The Research Methods Knowledge Base, William M. K. Trochim, James P. Donnelly, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Statistics for Management, Levin, R.I. and Rubin, D.S., 7th Edition, Pearson Education: New Delhi.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II					
MINOR PROJECT					
Course Code	**:**	**18MCE24**	**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:2**	**SEE Marks**	**:**	**100**
Hours/Week	**:**	**4**	**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes: After completing the course, the students will be able to

CO1	Conceptualize, design and implement solutions for specific problems.
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply resource managements skills for projects.
CO4	Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination

Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

Phase	Activity	Weightage
I	Synopsys submission, Preliminary seminar for the approval of selected topic and objectives formulation	20%
II	Mid term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

** Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/ experimental setup 25%
- Conducting experiments/ implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

SEMESTER : II						
MODERN ANTENNAS (Group C: Professional Elective)						
Course Code	**:**	**18MRM2C1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**10Hrs**
Introduction to Smart Antennas: Need for Smart Antennas, Overview, Smart Antenna Configurations, Space Division Multiple Access, Architecture of Smart Antenna System, Benefits, Drawbacks, Basic Principles, Mutual Coupling Effects.						
Unit – II						**10Hrs**
Beamforming: Fixed Weight Beamforming Basics - Maximum Signal-to-Interference Ratio, Minimum Mean-Square Error, Maximum Likelihood, Minimum Variance Adaptive Beamforming - Least Mean Squares, Sample Matrix Inversion, Recursive Least Squares Constant Modulus, Least Squares Constant Modulus, Conjugate Gradient Method, Spreading Sequence Array Weights, Description of the New SDMA Receiver.						
Unit – III						**10Hrs**
Angle-of-Arrival Estimation: Array Correlation Matrix, AOA Estimation Methods -Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, Root-MUSIC AOA Estimate, ESPRIT AOA Estimate.						
Unit – IV						**12Hrs**
Metamaterial Antennas: Introduction , Negative Refractive Index (NRI) Metamaterials , Metamaterial Antennas Based on NRI Concepts ,High-Gain Antennas Utilizing EBG Defect Modes, Antenna Miniaturization Using Dispersion Properties of Layered Anisotropic Media, Wideband Metamaterial Antenna Arrays.						
Unit – V						**10Hrs**
Reconfigurable Antennas: Introduction ,Analysis ,Overview of Reconfiguration Mechanisms for Antennas ,Control, Automation, and Applications.						
Course Outcomes **After successful completion of this course the student will be able to:**						
CO1	Elucidate parameters and principles of Adaptive Antennas, Metamaterial Antennas and Reconfigurable Antennas.					
CO2	Apply signal processing concepts in analyzing beamforming techniques.					
CO3	Analyze and Compare various techniques employed in designing Adaptive Antennas, Metamaterial Antennas and Reconfigurable Antennas.					
CO4	Compute design parameters of Adaptive Antennas, Metamaterial Antennas and Reconfigurable Antennas.					
Reference Books						
1.	Smart Antennas with Matlab: Principles and Applications in Wireless Communication, Frank B Gross,2015, McGraw-Hill Professional, New York, ISBN- 978-0-07-182494-1.					
2.	ration Design & Engineering, Frank B gross, 2011, Mcgraw Hill Publications, ISBN :					
3.	Introduction to Smart Antennas. Synth. Lect. Antennas, Balanis, C.A., Ioannides, P.I.: 2(1), 1–175,2007, 9781598291766.					
4.	Antenna Theory analysis and Design, Balanis A., 2nd Edition, 1997, John Wiley & Sons, New York. ISBN: 9780471592686.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MACHINE LEARNING (Group C: Professional Elective) (Common to VLSI,CS,CNE,DCE, BMI)						
Course Code	**:**	**18MCS2C2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**

Unit – I	**10Hrs**

Introduction:
Overview of Probability Theory, Model Selection, Introduction to Machine learning.
Linear Regression – Basis Function models, Bias Variance Decomposition, Bayesian linear Regression; Stochastic gradient Descent, Discriminant Functions, Bayesian Logistic regression. Examples on linear regression, logistic regression.

Unit – II	**10Hrs**

Supervised Learning:
Kernel Methods: Dual representations, Construction of a kernel, Radial Basis Function Networks, Gaussian Process, Tree Based methods .
Sparse Kernel Machines: Maximum margin classifiers (SVM), RVM.
Examples on spam, mixer and k nearest neighbour.

Unit – III	**10Hrs**

Unsupervised Learning:
Mixture Models: K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures, The EM Algorithm in General, Principal Component Analysis, Probabilistic PCA. Examples on Market booklet analysis

Unit – IV	**12Hrs**

Random Forests:
Introduction, Definition of Random Forests, Details of Random ,Out of Bag Samples , Variable Importance, Proximity Plots, Random Forests and Over-fitting, Analysis of Random Forests, Variance and the De-Correlation Effect, Bias, Adaptive Nearest Neighbors.

Unit – V	**10Hrs**

Ensemble Learning:
Introduction, Boosting and Regularization Paths, Penalized Regression, The "Bet on Sparsity" Principle, Regularization Paths, Over-fitting and Margins, Learning Ensembles, Learning a Good Ensemble, Rule Ensembles

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Explore the basics of Probability, data distributions and neural networks algorithms.
CO2	Apply the various dimensionality reduction techniques and learning models for the given application.
CO3	Analyze the different types of supervised and unsupervised learning models.
CO4	Evaluate the classification and regression algorithms for given data set.

Reference Books:

1.	**Pattern Recognition and Machine Learning, Springer**, Christopher M Bishop, 2006 ISBN-10: 0-387-31073-8, ISBN-13: 978-0387-31073-2.
2.	**Data Mining – Concepts and Techniques**, Jiawei Han and Micheline Kamber, 3rd Edition, , 2006, Morgan Kaufmann, ISBN 1-55860-901-6
3.	**The Elements of Statistical Learning**, Trevor Hastie, Robert Tibshirani, and Jerome Friedman2008, Springer, *ISBN* 978-0-387-84858 .

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ERROR CONTROL CODING (Group C: Professional Elective)						
Course Code	**:**	**18MDC2C3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**

Unit – I	**10Hrs**
Introduction to Algebra: Groups, Fields, Construction of Galois Field GF (2^m) and its basic properties, Vector spaces and Matrices **Linear Block Codes:** Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits.	
Unit – II	**10Hrs**
Cyclic Codes: Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding.	
Unit – III	**10Hrs**
BCH Codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction.RS Codes: Decoding of Non – Binary BCH and RS codes. The Berlekamp - Massey Algorithm.	
Unit – IV	**12Hrs**
Majority Logic Decodable Codes: One – Step Majority logic decoding, Two – step Majority logic decoding, Multiple – step Majority logic decoding.	
Unit – V	**10Hrs**
Turbo Codes: Introduction to Turbo coding and their distance properties. **TCM:** Introduction, TCM code construction.	

Course Outcomes **After successful completion of this course the student will be able to:**	
CO1	Apply the concepts of linear algebra in channel encoding and decoding
CO2	Analyze properties of different codes and their selection for communication applications.
CO3	Develop Encoding and decoding algorithms
CO4	Design and implement encoding and decoding circuits.

Reference Books:	
1.	Error Control Coding, Shu Lin & Daniel J. Costello, Jr, 2nd Edition, 2004, Pearson / Prentice Hall, ISBN 0-13-283796-X.
2.	Theory and Practice of Error Control Codes, R.E Blahut, 1984, Addison Wesley, *ISBN* 0894120638.
3.	The Theory of Error Correcting Codes, F.J. Mac Williams and N.J.A. Slone, 1977, North Holland, *ISBN*-10: 9780444851932.
4.	Bernard Sklar, Digital Communications - Fundamentals and Applications, 2nd Edition Pearson Education (Asia) Ptv. Ltd, 2001.ISBN 10: 0130847887, ISBN 13: 9780130847881.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MULTIMEDIA COMMUNICATION (Group D: Professional Elective)						
Course Code	**:**	**18MDC2D1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**10Hrs**
Multimedia Communications: Multimedia information representation, multimedia networks, multimedia applications, network QoS and application QoS.						
Unit – II						**10Hrs**
Video compression: Video compression principles, video compression standards: H.261, H.263, MPEG 1, MPEG 2, and MPEG 4. DivX, Flash Video, Avi, WMV.						
Unit – III						**10Hrs**
Standards and Protocols: JPEG 2000 compression standard – development process, features, architecture, bit stream, MPEG – 21 multimedia framework, Protocols - RTP, RTCP, RTSP, RSVP, DVMRP.						
Unit – IV						**12Hrs**
Multimedia Entertainment Networks: Introduction, Cable TV networks, Satellite TV networks, Terrestrial TV networks. High speed PSTN access Technologies.						
Unit – V						**10Hrs**
Digital Video Broadcasting: DVB Interoperabilities, DVB System, Baseband processing, Digital Television, Services over IP-based networks, Services, Authentication, Authorization. **DVB and Internet:** IP Multicast, Audio/Video streaming.						
Course Outcomes **After successful completion of this course the student will be able to:**						
CO1	Explain multimedia information representation, networks and compression techniques.					
CO2	Analyze applications like interpersonal communication, interactive communication over the internet and entertainment networks.					
CO3	Apply various coding methods and compression techniques.					
CO4	Analyze and explain the various broadcasting systems.					
Reference Books						
1.	Multimedia Communications, Fred Halsall, 2001, Pearson education, ISBN: 978-81-317-0994-8.					
2.	Introduction to Multimedia Communications, K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, 2014, Wiley, ISBN 13 978-0-471-46742-7.					
3.	Multimedia Communication Systems, K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic,, 2004, Pearson education, ISBN: 013031398X.					
4.	Fundamentals of Wireless Sensor Networks Theory and Practice, Waltenegus Dargie and Christin Poellabauer, 1st Edition John Wiley 2010, ISBN 978-0-470-99765-9.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED VLSI (Group D: Professional Elective)						
Course Code	**:**	**18MDC2D2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**
Unit – I						**10Hrs**
Review of MOS Transistor theory, MOSFET scaling, Small-geometry effects, Design of CMOS inverters with VTC, Design rules, Supply voltage scaling in CMOS inverters.						
Unit – II						**10Hrs**
CMOS Circuits: Pass transistors, Voltage Bootstrapping, Dynamic CMOS circuit technique: CMOS Transmission gate logic, Dynamic CMOS logic, Domino CMOS logic, NORA CMOS logic, Zipper CMOS circuits, TSPC Dynamic circuits, BiCMOS circuits.						
Unit – III						**10Hrs**
Design Methodology, Design flows, Interchange formats: Clock system architecture, Global clock generation, Global clock distribution, Local clock gaters.						
Unit – IV						**12Hrs**
Low-Power CMOS Logic Circuits: Overview of power consumption, Low-power design through voltage scaling, Estimation and optimization of switching activity, Adiabatic logic circuits.						
Unit – V						**10Hrs**
Testability and Verification: Logic verification, manufacturing tests, test programs, Logic verification principles, Silicon debug principles, Fault models, Controllability and Observability. DFT: Ad-hoc, Scan-based, and BIST techniques, Boundary scan.						
Course Outcomes **After successful completion of this course the student will be able to:**						
CO1	Apply the fundamentals of semiconductor physics and explain geometrical effects in MOS transistors.					
CO2	Analyze the various design flows in IC design and clock generation/distribution networks.					
CO3	Justify the need of scaling, low power design, testing and verification in CMOS IC design.					
CO4	Design and realize digital circuits using variants of CMOS logic.					
Reference Books						
1.	CMOS Digital Integrated Circuits, Sung-Mo Kang and Yusuf Leblebici 3rd Edition, 2012, Tata McGraw Hill, ISBN-0070530777.					
2.	CMOS VLSI Design: A Circuits and Systems Perspective, Neil H.E. Weste, David Harris and Ayan Banerjee, 3rd Edition, 2011, Pearson education, ISBN- 0321547748.					
3.	Deep-Submicron CMOS ICs, Harry Veendrick, 2nd Edition, 2000, Kluwer academic publishers, ISBN-9044001116.					
4.	Basic VLSI Design, Douglas A. Pucknell, Kamran Eshraghian PHI, Third edition, 2002, *ISBN:* 9788120309869.					

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
BROADBAND NETWORKS (Group D: Professional Elective)						
Course Code	**:**	**18MDC2D3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03Hrs**

Unit – I	**10Hrs**
Background of LTE: Introduction, ITU Activities, Drivers For LTE, Standardization of LTE. **Overview of LTE Radio Access:** Basic principles, LTE release 9, LTE release 10 and IMT-Advanced, Terminal capabilities.	
Unit – II	**10Hrs**
Radio-Interface Architecture: Overall System Architecture, Radio Protocol Architecture, Control-Plane Protocols.	
Unit – III	**10Hrs**
Physical Transmission Resources: Overall Time–Frequency Structure, Normal Sub frames and MBSFN Sub frames, Carrier Aggregation, Frequency-Domain Location of LTE Carriers, Duplex Schemes.	
Unit – IV	**12Hrs**
Spectrum: Spectrum for LTE, Flexible Spectrum Use, Flexible Channel Bandwidth Operation, Carrier Aggregation For LTE, Multi-Standard Radio Base Stations.	
Unit – V	**10Hrs**
RF Characteristics of 4G: Overview of RF Requirements for LTE, Output Power Level Requirements, Transmitted Signal Quality, Unwanted Emissions Requirements, **Overview of 5G:** Global initiatives and Standardization activities, Use cases and requirements, Spectrum challenges,5G spectrum landscape and requirements	

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Discuss the standardization, resources and requirements of 4G.
CO2	Analyze the architectures of 4G technologies.
CO3	Recommend the transmission resources and Spectrum to design LTE system
CO4	Asses the LTE system from RF perspective.

Reference Books

1.	4G LTE/LTE-Advanced for Mobile Broadband, Erik Dahlman, Stefan Parkvall, and Johan Sköld, Academic Press,2011, ISBN: 978-0-12-385489-6.
2.	Advanced WirelessCommunications-4G Technologies, Savo Glisic, 2004, John Wiley & Sons Ltd, ISBN:13 978-0-470-01593-3 (HB), ISBN:10 0-470-01593-4 (HB).
3.	5G Mobile and Wireless Communications, Edited by Afif Osseiran, Jose F. Monserrat and Patrick Marsch, Cambridge University Press, 2016. ISBN:9781107130098
4.	5G NR: The Next Generation Wireless Access Technology, Erik Dahlman , Stefan Parkvall , and Johan Sköld , 1st Edition, Academic Press,2018.ISBN:978012814230

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II
BUSINESS ANALYTICS
(Global Elective-G01)

Course Code	**:**	**18CS2G01**	**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**	**SEE Marks**	**:**	**100**
Hours	**:**	**39L**	**SEE Duration**	**:**	**3 Hrs**

Unit – I | **08 Hrs**

Business analytics

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

Unit – II | **08 Hrs**

Trendiness and Regression Analysis

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit – III | **08 Hrs**

Organization Structures of Business analytics

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

Unit – IV | **08 Hrs**

Forecasting Techniques

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Unit –V | **07 Hrs**

Decision Analysis

Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Course Outcomes

After going through this course the student will be able to:

CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books

1	Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2	The Value of Business Analytics: Identifying the Path to Profitability, Evan Stubs , John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st Edition 2014
3	Business Analytics, James Evans, Pearsons Education 2nd Edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley; 1st Edition, 2013.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)						
Course Code	**:**	**18CV2G02**		**CIE**	**:**	**100 Marks**
Credits L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**7 Hrs**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.	
UNIT – II	**9 Hrs**
Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.	
UNIT – III	**9 Hrs**
Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.	
UNIT – IV	**7 Hrs**
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	
UNIT – V	**7 Hrs**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.	

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books	
1.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
2.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MODELING USING LINEAR PROGRAMMING (Global Elective-G03)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	
Unit – II	**08 Hrs**
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	
Unit – III	**08 Hrs**
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	
Unit – IV	**08 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	
Unit –V	**07 Hrs**
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books

1	Operation Research An Introduction, Taha H A, 8th Edition, 2009, PHI, ISBN: 0130488089.
2	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg - John 2nd Edition, 2000, Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-81-265-1256-0
3	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 9th Edition, 2012, Tata McGraw Hill ISBN 13: 978-0-07-133346-7
4	Operations Research Theory and Application, J K Sharma, 4th Edition, 2009, Pearson Education Pvt Ltd, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PROJECT MANAGEMENT (Global Elective-G04)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.

Unit – II **08 Hrs**

Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting

Unit – III **08 Hrs**

Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis

Unit – IV **08Hrs**

Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management

Unit-V **07 Hrs**

Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile.

Domain Specific Case Studies on Project Management: Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.

Course Outcomes
After going through this course the student will be able to:

CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books

1	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 8th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.
2	A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 11th Edition, 2013, John Wiley & Sons Inc., ISBN 978-1-118-02227-6.
4	Project Management – Planning and Controlling Techniques, Rory Burke, 4th Edition, 2004, John Wiley & Sons, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ENERGY MANAGEMENT (Global Elective-G05)						
Course Code	**:**	**18CH2G05**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**08 Hrs**

Energy conservation:
Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.

Unit-II	**08 Hrs**

Wet Biomass Gasifiers:
Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages

Unit –III	**08 Hrs**

Dry Biomass Gasifiers :
Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.

Unit –IV	**08Hrs**

Solar Photovoltaic:
Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication.
Wind Energy:
Classification, Factors influencing wind, WECS & classification.

Unit –V	**07 Hrs**

Alternative liquid fuels:
Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet. Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Understand the use alternate fuels for energy conversion
CO2	Develop a scheme for energy audit
CO3	Evaluate the factors affecting biomass energy conversion
CO4	Design a biogas plant for wet and dry feed

Reference Books

1	Nonconventional energy, Ashok V Desai, 5th Edition, 2011, New Age International (P) Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN: 9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRY 4.0 (Global Elective-G06)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit – II	**08 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	
Unit – III	**08 Hrs**
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	
Unit – IV	**08 Hrs**
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	
Unit –V	**08 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books

1	Industry 4.0 the Industrial Internet of Things, Alasdair Gilchrist, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, Springer, 2018 ISBN 978-3-319-57869-9.
3	Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Ovidiu Vermesan and Peer Friess, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4	The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED MATERIALS (Global Elective-G07)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	
Unit – II	**08 Hrs**
Non Metallic Materials: Classification of n on metallic materials, Rubber: Properties, processing and applications. Plastics: Thermosetting and Thermoplastics, Applications and properties. Ceramics: Properties and applications. Adhesives: Properties and applications. Optical fibers: Properties and applications. Composites : Properties and applications.	
Unit – III	**08 Hrs**
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	
Unit – IV	**08 Hrs**
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	
Unit –V	**08 Hrs**
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	

Course Outcomes
After going through this course the student will be able to:

CO1	Describe metallic and non metallic materials
CO2	Explain preparation of high strength Materials
CO3	Integrate knowledge of different types of advanced engineering Materials
CO4	Analyse problem and find appropriate solution for use of materials.

Reference Books

1	The Science & Engineering of Materials, Donald R. Askeland, and Pradeep P. Fulay, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Nanotechnology, Gregory L. Timp, 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Material Science and Metallurgy, Dr. VD Kodgire and Dr. S V Kodgire, 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	Processing and Fabrication of Advanced Materials, N Bhatnagar, T S Srivatsan, 2008, IK International, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Global Elective-08)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I — **08 Hrs**

Introduction to composite materials

Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced

composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.

Unit – II — **08 Hrs**

Polymer matrix composites (PMC)

Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers,

Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**

Unit -III — **08 Hrs**

Ceramic matrix composites and special composites

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics

– need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

Unit –IV — **07 Hrs**

Metal matrix composites

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process,

Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries.

Unit –V — **08 Hrs**

Polymer nano composites

Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles. Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques. Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM. Mechanical and Rheological properties of Polymer Nano composites. Gas barrier,

Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.	
Course Outcomes **After completing the course, the students will be able to:**	
CO1	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
CO2	Identify the basic constituents of a composite materials and list the choice of materials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nano-materials
Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition Springer-verlag Gmbh,2012 , ISBN: 978-0387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6th Edition- Cengage, Publishers,2013, ISBN: 13: 978-8131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, 2014, ISBN: 13: 978-0137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, 2010, ISBN: 10-9781498761666, 1498761666

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PHYSICS OF MATERIALS (Global Elective-09)						
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Crystal Structure

Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg's law, Powder method, Bragg's spectrometer, Qualitative Analysis of Crystal structure using XRD,
Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.

Unit – II **08 Hrs**

Dielectric Materials

Basic concepts, Langevin's Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polarizability as a function of frequency), Qualitative discussion of Internal Field and Claussius Mossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect,

Coupling factor, spontaneous polarization, Piezolelectricty in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.

Unit – III **08 Hrs**

Magnetic Materials

Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron
and SQUID.

Unit – IV **07 Hrs**

Semiconducting Materials

Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement-quantum wires and dots, size dependent properties, Top down approach, Fabrication process by Milling and Lithography, Bottom up approach, fabrication process by vapour phase expansion and
vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.

Unit –V **08 Hrs**

Novel Materials

Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoeleasticity, Transformation hysteresis, Superelasticity, Characterization technique-Differntial Scanning calorimetry, Preparation technique- spin coating, Nitinol, CuAlNi alloy and applications.

Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys,
Carbon nanotubes, Graphene- Properties and Applications.

Course Outcomes

After going through this course the student will be able to:

CO1	Apply the principles of Physics in Engineering.
CO2	Apply the knowledge of Physics for material analysis.
CO3	Identify and Analyze Engineering Problems to achieve practical solutions.
CO4	Develop solutions for Problems associated with Technologies.

Reference Books

1.	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.
2.	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-780
3.	Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar, S Chand Publishing, Reprint

	2015.
4.	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED STATISTICAL METHODS (Global Elective-G10)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Sampling Techniques: Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement), Sampling distribution of proportions, Expectation and standard error of sample mean and proportion, Sampling distributions of differences and sums.	
Unit – II	**08 Hrs**
Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Confidence intervals-population mean (large sample).	
Unit – III	**08 Hrs**
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples. Simple and composite hypotheses. Null and alternative hypotheses. Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Exact and asymptotic tests of proportions. Chi squared test for goodness of fit (Relevant case studies).	
Unit – IV	**07 Hrs**
Linear Statistical Models: Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell (Relevant case studies).	
Unit –V	**09 Hrs**
Linear Regression: Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.	

Course Outcomes
After going through this course the student will be able to:

CO1	Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.
CO2	Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions.
CO3	Analyse the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.

Reference Books

1.	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.
2.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, John Wiley & Sons, 2014, ISBN:13 9781118539712, ISBN (BRV):9781118645062.
3.	Fundamentals of Mathematical Statistic-A Modern Approach, S.C. Gupta and V.K. Kapoor, 10th Edition, 2000, S Chand Publications, ISBN: 81-7014-791-3.
4.	Regression Analysis: Concepts and Applications, F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.