Go, Change the world®

RV Educational Institutions ®
RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

Approved by AICTE, New Delhi

Scheme and Syllabus of I – IV semester

(Autonomous System of 2022 Scheme)

Master of Technology (M. Tech.)

in

COMMUNICATION SYSTEMS (MCS)

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Academic Year 2022-23

Estd.1963

Go, change the world

RV COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, 8th Mile, Mysuru Road, Bengaluru - 560 059.

2022 Ranked 89th in Engineering Category

One of the most preferred Technical Institutions

Accredited by NBA

PROGRAMS OFFERED

B.E. Programs : AI, AS, BT, CH, CS, CV, CD, CY, EC, EE, EI, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)

Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

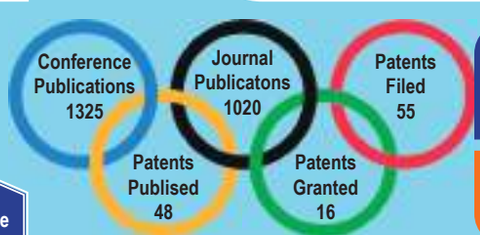
Five RVCE Alumni cleared Civil Services Exam in 2020-21

Ranked in top 10 Pvt. College in the Country by various magazines

Ranked 3rd in Sports & Cultural Activities under VTU (2019-20)

Use of ICT in Teaching Learning Process

e-Journals e-books | QEE 48 Courses | SWAYAM | NPTEL 9,300+ Enrolled 68th place in the country (Jul-Oct-2019) | Wikispace | MOOCS | MODULE



Holistic development of students through NCC, NSS Cultural activities, Community service & Sports.

16 Centres of Excellences
07 Centres of Competence

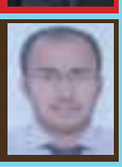
MoUs: 90+with Industries / Academic Institutions in India & abroad

Executed more than Rs. 40 crores worth sponsored research projects & consultancy works sicnce 3 years

UPSC Results (2020): RVCE-Alumni

Name : Kushal Jain
Rank : 40
ISE-2016 Pass out

Name : Naveen Kumar
Rank : 62
ME - Pass out



Name : Deepak R. Shet
Rank : 311
ECE – 2013 Pass out

Human Resource

Faculty with Industrial experience 104
Visiting Adjunct Faculty 05
Total Number of Faculty 347
Faculty with Ph.D. Qualification 240
Faculty Pursuing Ph.D. 87
Technical & Admin Staff 221

RVCE - Greaves Cotton Ltd Centre of excellence in e-mobility

RV-Mercedes Benz Centre for Automotive Mechatronics

World University Rankings	1501+
Subject Ranking - Engineering	1001+
Subject Ranking - Computer Science	801+

Glossary of Abbreviations

1.	AS	Aerospace Engineering
2.	BS	Basic Sciences
3.	BT	Biotechnology
4.	CH	Chemical Engineering
5.	CHY	Chemistry
6.	CIE	Continuous Internal Evaluation
7.	CS	Computer Science & Engineering
8.	CV	Civil Engineering
9.	EC	Electronics & Communication Engineering
10.	EE	Electrical & Electronics Engineering
11.	EI	Electronics & Instrumentation Engineering
12.	ET	Electronics & Telecommunication Engineering
13.	GE	Global Elective
14.	HSS	Humanities and Social Sciences
15.	IM	Industrial Engineering & Management
16.	IS	Information Science & Engineering
17.	L	Laboratory
18.	MA	Mathematics
19.	MBT	M. Tech in Biotechnology
20.	MCE	M. Tech. in Computer Science & Engineering
21.	MCN	M. Tech. in Computer Network Engineering
22.	MCS	M. Tech. in Communication Systems
23.	MDC	M. Tech. in Digital Communication
24.	ME	Mechanical Engineering
25.	MHT	M. Tech. in Highway Technology
26.	MIT	M. Tech. in Information Technology
27.	MMD	M. Tech. in Machine Design
28.	MPD	M. Tech in Product Design & Manufacturing
29.	MPE	M. Tech. in Power Electronics
30.	MSE	M. Tech. in Software Engineering
31.	MST	M. Tech. in Structural Engineering
32.	MVE	M. Tech. in VLSI Design & Embedded Systems
33.	N	Internship
34.	P	Projects (Minor / Major)
35.	PHY	Physics
36.	SDA	Skill Development Activity
37.	SEE	Semester End Examination
38.	T	Theory
39.	TL	Theory Integrated with Laboratory
40.	VTU	Visvesvaraya Technological University

POSTGRADUATE PROGRAMS

Sl. No	Core Department	Program	Code
1.	BT	M. Tech in Biotechnology	MBT
2.	CS	M. Tech in Computer Science & Engineering	MCE
3.	CS	M. Tech in Computer Network Engineering	MCN
4.	CV	M. Tech in Structural Engineering	MST
5.	CV	M. Tech in Highway Technology	MHT
6.	EC	M. Tech in VLSI Design & Embedded Systems	MVE
7.	EC	M. Tech in Communication Systems	MCS
8.	EE	M. Tech in Power Electronics	MPE
9.	ET	M. Tech in Digital Communication	MDC
10.	IS	M. Tech in Software Engineering	MSE
11.	IS	M. Tech in Information Technology	MIT
12.	ME	M. Tech in Product Design & Manufacturing	MPD
13.	ME	M. Tech in Machine Design	MMD

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

VISION

Imparting quality technical education through interdisciplinary research, innovation and teamwork for developing inclusive & sustainable technology in the area of Electronics and Communication Engineering

MISSION

1. To impart quality technical education to produce industry-ready engineers with a research outlook.

2. To train the Electronics & Communication Engineering graduates to meet future global challenges by inculcating a quest for modern technologies in the emerging areas.

3. To create centres of excellence in the field of Electronics & Communication Engineering with industrial and university collaborations.

4. To develop entrepreneurial skills among the graduates to create new employment opportunities

PROGRAMME OUTCOMES (PO)

M. Tech in **Communication Systems** graduates will be able to:

PO1: Independently carry out research/investigation and development work to solve the practical problems related to Communication Systems.

PO2: Write and present a substantial technical report/document in the field of Communication Systems.

PO3: Demonstrate a degree of mastery over the area of Communication Systems. The mastery should be level higher than the requirements of bachelor's in Electronics & Communication Engineering program.

PO4: Abstract the requirements of communication scenarios and offer innovative solutions with available communication modules and interfaces.

PO5: Design and develop wireless and wireline communication system modules with good economics to meet Quality of Service.

PO6: Acquire professional and intellectual integrity, research ethics and execute socio-concern projects related to communication systems.

INDEX

19	22HSS42	Professional Skills Development-II	--

M.Tech in Communication Systems: MCS

I SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/ SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	22MAT11DT	Statistical Learning for Communication	3	1	0	**4**	MA	Theory	1.5	100	3	100
2	22MCS12TL	Advanced Communication Systems-1	3	0	1	**4**	EC	Theory+Lab	1.5	100	3	100
3	22MCS13T	Communication Networks and Protocols	3	1	0	**4**	EC	Theory	1.5	100	3	100
4	22MCS14L	Programming and Network Simulation Lab	1	0	1	**2**	EC	Lab	1.5	50	3	50
5	22XXX1AXT	Elective A (Professional Elective)	3	0	0	**3**	EC	Theory	1.5	100	3	100
6	22MCS1BXT	Elective B (Professional Elective)	3	0	0	**3**	EC	Theory	1.5	100	3	100

Note: For the course code 22HSS42, Students need to select one ONLINE MOOC course as recommended by HSS BoS. This course can be selected anytime between I to III semester and it will be evaluated during IV semester.

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Code	Elective A (Professional Elective)	Code	Elective B (Professional Elective)
22MCS1A1T	Advanced Embedded Computing Devices	22MCS1B1T	Digital System Design Using HDL
22MCS1A2T	Multirate Systems and Filter Banks	22MCS1B2T	Multimedia Communication and Networking
22MVE1A3T	VLSI Digital Signal Processing	22MCS1B3T	Optical Communications and Networks

II SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/ SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	22IM21T	Research Methodology	3	0	0	**3**	IM	Theory	1.5	100	3	100
2	22MCS22TL	Advanced Communication Systems-2	3	0	1	**4**	EC	Theory+Lab	1.5	100	3	100
3	22MCS23T	Smart Antennas and Algorithms	3	0	0	**3**	EC	Theory	1.5	100	3	100
4	22XXX2CXT	Elective C (Professional Elective)	3	0	0	**3**	EC	Theory	1.5	100	3	100
5	22XXX2DXXT	Elective D (Global Elective)	3	0	0	**3**	Res. BoS	Theory	1.5	100	3	100
6	22MCS24L	Simulation and Characterisation of RF Devices	1	0	1	**2**	EC	Lab	1.5	50	3	50
7	22HSS25T	Professional Skills Development-I	2	0	0	**2**	HSS	Theory*	1.5	50	2	50

** External Agency will be conducting the classes and both CIE and SEE will be evaluated by the Agency.*

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Code	Elective C (Professional Elective)
22MCS2C1T	Development of Modem SoCs for Wireless, Wireline and IOT applications
22MDC2C1T	RF and Microwave Circuit Design for Wireless Communication Systems
22MVE2C3T	Robotics and Industrial Automation

22MCS2C4T: Advanced 5G

Elective D (Global Elective)			
22BT2D01T	Bioinspired Engineering	22ET2D08T	Tracking and Navigation Systems
22BT2D02T	Health Informatics	22IM2D09T	Project Management
22CS2D03T	Business Analytics	22IS2D10T	Database and Information Systems
22CV2D04T	Industrial and Occupational Health and Safety	22IS2D11T	Management Information Systems
22CV2D05T	Intelligent Transportation Systems	22MAT2D12T	Statistical and Optimization Methods
22EC2D06T	Electronic System Design	22ME2D13T	Industry 4.0
22EC2D07T	Evolution of Wireless Technologies		

III SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	22MCS31T	Error Control Coding for Wireless Communication	3	1	0	**4**	EC	Theory	1.5	100	3	100
2	22MCS3EXT	Elective E (Professional Elective)	3	1	0	**4**	EC	Theory	1.5	100	3	100
3	22MCS32N	Internship	0	0	6	**6**	EC	Internship	1.5	50	3	50
4	22MCS33P	Minor Project	0	0	6	**6**	EC	Project	1.5	50	3	50
						20						

Code	Elective E (Professional Elective)
22MCS3E1T	Next Generation Wireless LANs
22MCS3E2T	Cyber Security
22MCS3E3T	Modern Radar Systems

IV SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	22MCS41P	Major Project	0	0	18	**18**	EC	Project	1.5	100	3	100
2	22HSS42	Professional Skills Development-II	2	0	0	**2**	HSS	NPTEL	--	50	ONLINE	50
Student need to submit the certificate for the evaluation of Course code 22HSS42												
						20						

SEMESTER: I

Course Code	:	22MAT11DT	**Statistical Learning for Communication**	CIE Marks	:	100
Credits L-T-P	:	3-1-0		SEE Marks	:	100
Hours	:	42L+28T		SEE Durations	:	**3 Hrs**
Faculty Coordinator:		**Dr. Prakash R**				

UNIT - I **08 Hrs**

Introduction to Machine Learning:
Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, Overview of supervised learning, Linear regression models and least squares, shrinkage methods-ridge regression, Lasso regression, Methods using derived input directions-Principal component regression, Logistic regression. Applications to communications.

UNIT - II **09 Hrs**

Basis Expansions and Regularization:
Piecewise polynomials and splines, Filtering and feature extraction, Smoothing splines, Nonparametric logistic regression, Multidimensional splines, Wavelet smoothing and applications to image processing.
Bayesian and Computational Learning:
Bayes theorem, Bayes theorem concept learning, Maximum likelihood, Minimum description length principle, Bayes optimal classifier, Gibbs algorithm, Naïve Bayes classifier. Applications to statistical communication.

UNIT - III **09 Hrs**

Model Assessment and Selection:
Confusion matrices, Performance measures – Precision, recall, F-score, ROC curves, Bias, Variance and model complexity, Model selection and the Bias–variance trade-off. Cross-validation, Bootstrap methods.
Model Inference and Averaging:
Bootstrap and maximum likelihood methods, Bayesian methods, Relationship between the bootstrap and Bayesian inference, EM algorithm, Bagging and bumping. Applications to communications.

UNIT - IV **08 Hrs**

Tree based Models and Neural Networks:
Decision tree representation , Inductive bias in decision tree, issues in decision tree, Tree-based methods – Classification trees, Decision trees for regression, Random forests, Boosting methods-Steepest descent, Gradient boosting.
Neural networks - Neural network representation, Multilayer networks and back propagation algorithms, Some issues in training neural networks, Bayesian neural networks. Applications to neural networks and communications.

UNIT - V **08 Hrs**

Support Vector Machines and Flexible Discriminants:
Support vector machines and kernels, Support vector classifier, Separating hyperplanes, Generalizing linear discriminant analysis, Flexible discriminant analysis, Prototype methods, k- nearest-neighbor classifiers, Adaptive nearest-neighbor methods, Applications to array signal processing.

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

CO1	:	Illustrate the fundamental concepts of various machine learning models which are used in Communication systems.
CO2	:	Derive the solution by applying the acquired knowledge of statistics and mathematics via machine learning approach to model and solve the application problems of Communication systems.
CO3	:	Evaluate the solution of the problems using appropriate statistical and mathematical learning model techniques to the real world problems arising in many practical situations.
CO4	:	Compile the overall knowledge of statistical learning for communication gained to apply and engage in life – long learning.

Reference Books:

1. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer Series in Statistics, 2nd Edition, 2009
2. Statistical Machine Learning: A Unified Framework, Richard M. Golden, Chapman and Hall/CRC; 1st edition, 2020, ISBN-10:1138484695
3. K R Murphy, “Machine Learning-A Probabilistic Perspective”, 1st Edition, MIT Press, 2012, ISBN-10:0262018020

4. C M Bishop, "Pattern Recognition and Machine Learning", 1st Edition, Springer, 2006, ISBN-10:0387310738

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I

Course Code	:	22MCS12TL	**Advanced Communication Systems-1**	CIE Marks	:	100
Credits L-T-P	:	3-0-1	*(Theory & Practice)*	SEE Marks	:	100
Hours	:	42L + 28P	*(Professional Core - 2)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. S Ravishankar				

UNIT - I **9 Hrs**

Signal Representation – Low pass representation of bandpass signals, Low pass representation of bandpass random process. Multiplexing, De-multiplexing and Frame Synchronization of Signals.
Modulation: Modulation Schemes without memory (Band Limited Schemes - PAM, BPSK, QPSK, MPSK, MQAM, and Power Limited Schemes – FSK, MFSK, DPSK, DQPSK), modulation schemes with memory (MSK), Transmit PSD for Modulation Schemes.

UNIT - II **9 Hrs**

Demodulation - Vector Channel, Vector Channel +AWGN, Performance parameters – SER,BER and EVM, Optimum Coherent Detection for power limited and Bandlimited schemes, Optimal Coherent detection for MSK, Optimal Non – Coherent detection for schemes without and with memory (FSK, DPSK, DQPSK).

UNIT - III **8 Hrs**

Bandlimited Channels: Bandlimited channel characterization, signalling through band limited linear filter channels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes, Optimum receiver for channel with ISI and AWGN. Linear Equalizers: Zero forcing Equalizer, MSE and MMSE, Baseband and Passband Linear Equalizers. Performance of ZFE and MSE.

UNIT - IV **8 Hrs**

Non-Linear Equalizers: Decision - feedback equalization, Predictive DFE, Performance of DFE. Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive Fractionally spaced Equalizer (Tap Leakage Algorithm).

UNIT - V **8 Hrs**

Synchronization - Signal Parameter Estimation - The Likelihood Function for Carrier Recovery and Symbol Synchronization in Signal Demodulation. Carrier Phase Estimation - ML Carrier Phase Estimation, The PLL, Effect of Additive Noise on the Phase Estimate, Decision-Directed and Non-Decision-Directed Loops. Symbol Timing Estimation - ML Timing Estimation, Non-Decision-Directed Estimation

LABORATORY **28 Hrs**

1. Generation and study the properties of Line codes.
2. Pulse Amplitude Modulation and Demodulation.
3. ASK Modulation and Demodulation
4. Binary Phase Shift Keying Modulation and Demodulation
5. Frequency Shift Keying Generation and detection
6. QPSK Modulation and Demodulation
7. QAM Modulation and Demodulation
8. Minimum Shift Keying Modulation
9. Generation of PN Sequence and Gold sequence
10. Design of Linear Equalizers and AI based Equalizer

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

CO1	:	Explain the concept of low pass and Bandpass signals representations at the Transmitter, the process of Detection and Estimation at the receiver in the presence of AWGN only.
CO2	:	Evaluate Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-band limited and band limited channels.
CO3	:	Design single carrier equalizers for various symbol modulation schemes and detection methods for defined channel models, and compute parameters to meet desired rate and performance requirements.
CO4	:	Design and develop Carrier recovery , Timing recovery and Frame recovery schemes for specific single carrier application in wireless, wireline domains

Reference Books

1. Digital Communications, John G. Proakis, Masoud Salehi, 5th Edition, Pearson Education, 2014, ISBN:9789339204792

2. Digital Communications: Fundamentals and Applications: Fundamentals &Applications, Bernard Sklar,2nd Edition, Pearson Education, 2009, ISBN:978-8131720929

3. Digital Communications Systems, Simon Haykin ,1st Edition ,Wiley, 2014, ISBN:978-8126542314

4. Signal Detection and Estimation, Mourad Barkat, 2nd Edition, Artech house, 2005, ISBN: 1580530702

Scheme of Continuous Internal Evaluation (CIE): 10 + 30 + 30 + 30 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The average of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 30 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (10), Video based seminar /presentation /demonstration (20) adding upto 30 marks.

Laboratory: Conduction of laboratory exercises, Lab report & observation & analysis (30 Marks), Lab Test (10 Marks) & Innovative Experiment/Concept Design & Implementation (10 Marks) adding up to 50 Marks. The final marks will be reduced to 30 Marks.

Scheme of Semester End Examination (SEE) for 100 marks: Each unit consists of TWO Questions of 16 Marks each. Answer FIVE full questions selecting one from each unit (from 1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.

Rubric for CIE & SEE for Integrated Theory courses with Laboratory

RUBRIC of CIE			***RUBRIC of SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	10	Each unit consists of TWO questions of 16 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.		
2	Tests - T1 & T2	30			
3	Experiential Learning - EL1 & EL2	30	1 & 2	Unit-1: Question 1 or 2	16
4	Laboratory	30	3 & 4	Unit-2: Question 3 or 4	16
	Total Marks	100	5 & 6	Unit-3: Question 5 or 6	16
NO SEE for Laboratory			7 & 8	Unit-4: Question 7 or 8	16
			9 & 10	Unit-5: Question 9 or 10	16
			11	Laboratory Component (Compulsory)	20
				Total Marks	100

SEMESTER: I

Course Code	:	22MCS13T	**Communication Networks and Protocols**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L+ 28T	*(Professional Core - 3)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Kiran V				

UNIT - I **9 Hrs**

Foundation: Building a Network, Requirements, Perspectives, Scalable Connectivity, - Cost Effective Resource sharing, Support for Common Services, Manageability, Protocol layering, Performance, Bandwidth and Latency, Delay X Bandwidth Product, Perspectives on Connecting, Classes of Links, Reliable Transmission, Stop-and-Wait , Sliding Window, Concurrent Logical Channels.

UNIT - II **9 Hrs**

Internetworking I: Switching and Bridging, Datagram's, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Basic Internetworking (IP), What is an Internetwork?, Service Model, Global Addresses, Datagram Forwarding in IP, Subnetting and classless addressing, Address Translation (ARP) Host Configuration(DHCP), Error Reporting(ICMP), Virtual Networks and Tunnels

UNIT - III **8 Hrs**

Internetworking- II: Network as a Graph, Distance Vector(RIP), Link State(OSPF), Metrics, The Global Internet, Routing Areas, Routing among Autonomous systems(BGP), IP Version 6(IPv6), Mobility and Mobile IP

UNIT - IV **8 Hrs**

End-to-End Protocols: Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination, Triggering Transmission, Adaptive Retransmission, Record Boundaries, TCP Extensions

UNIT - V **8 Hrs**

Congestion Control and Resource Allocation: Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. The Domain Name System(DNS),Electronic Mail(SMTP,POP,IMAP,MIME),World Wide Web(HTTP),Network Management(SNMP)

Course Outcomes:

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

CO1	:	Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
CO2	:	Design and configure network topology and addressing scheme for the given application
CO3	:	Analyze TCP/IP suite, routing Algorithm's, Protocols and their functionalities
CO4	:	Design, analyse, and evaluate networks and services for homes, data centres, IoT/IoE, LANs and WANs.

Reference Books

1. Larry Peterson and Bruce S Davis "Computer Networks :A System Approach" 5th Edition , Elsevier -2014

2. Douglas E Comer, " Internetworking with TCP/IP, Principles, Protocols and Architecture" 6th Edition, PHI - 2014

3. Uyless Black "Computer Networks, Protocols , Standards and Interfaces" 2nd Edition – PHI, ISBN: 8120310411, 1996

4. Behrouz A Forouzan "TCP /IP Protocol Suite" 4th Edition – Tata McGraw-Hill, ISBN: 0070706522, 2017

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I							
Course Code	:	22MCS14L	**Programming and Network simulation LAB**	CIE Marks	:	50
Credits L-T-P	:	1-0-1		SEE Marks	:	50
Hours	:	14L + 28P	*(Coding / Skill Laboratory)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Kiran V			

Content	**28 Hrs**
"Part –I: Experiments Using C/C++ programming. 1. Bit stuffing & character stuffing. 2. Cyclic Redundancy check. 3. Implement leaky bucket congestion control algorithm 4. Minimum spanning tree. Part-II 1. Design an Ethernet network comprising of 25 nodes and calculate Packet delivery ratio given the packet size to be 1024 bytes, consider the following application layer protocols a. FTP b. CBR 2. Simulate an IBSS (Independent Basic Service Set) network / Ad-hoc network using 500 sq.km. terrain and plot the output characteristics for a). Packet Delivery Ratio b) Throughput c). Average Jitter d) RTS / CTS and acknowledgement. 3. Simulate a wireless scenario with different two routing protocol distance vector routing protocol (AODV) and Link state routing protocol (OLSR) , analyze statistics for two routing protocol. 4. Implement a four node point to point network with links n0-n2, n1-n2and n2-n3. Apply TCP agent between n0-n3 and UDP between n1-n3.Apply relevant applications over TCP and UDP agents by changing the parameters and determine the number of packets sent by TCP/UDP 5. Implementation of Link state routing algorithm." 6. Illustration of Cryptography in practical applications- A case study	

Course Outcomes:

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

CO1	:	Explain the performance of various Flow control protocols.
CO2	:	Design the network protocol for given specifications of applications.
CO3	:	Design & develop the scheduling algorithms for various performance metrics.
CO4	:	Develop various network traffic management and control techniques for given specification

Reference Books

1. Larry Peterson and Bruce S Davis “Computer Networks :A System Approach” 5th Edition , Elsevier -2014

2. Douglas E Comer, “ Internetworking with TCP/IP, Principles, Protocols and Architecture” 6th Edition, PHI - 2014

3. Uyless Black “Computer Networks, Protocols , Standards and Interfaces” 2nd Edition – PHI, ISBN: 8120310411, 1996

4. Behrouz A Forouzan “TCP /IP Protocol Suite” 4th Edition – Tata McGraw-Hill, ISBN: 0070706522, 2017

Scheme of Continuous Internal Evaluation (CIE- Laboratory) : Only LAB Course 30 + 10 + 10 = 50. The Laboratory session is held every week as per the timetable and the performance of the student is evaluated in every session. The average of marks over number of experiments conducted over the weeks is considered for 30 Marks i.e (Lab Report, Observation & Analysis). The students are encouraged to implement additional innovative experiments in the lab (10 marks). At the end of the semester a test is conducted for 10 Marks (Lab Test). This adds to 50 Marks.

Scheme of Semester End Examination (SEE- Laboratory) : Only LAB Course 40 + 10 =50. Students will be evaluated for Write-up, Experimental Setup, Experiment Conduction with Results, Analysis & Discussions for 40 Marks and Viva will be conducted for 10 Marks adding to 50 Marks.

Only LAB Courses with 50 Marks

RUBRIC FOR CIE			RUBRIC FOR SEE	
Sl.No	Content	Marks	Content	Marks
1	Write Up, Setup, Conduction Results, Analysis & Discussions	30	1. Write Up, Setup, Conduction 2. Results, Analysis & Discussions	40
2	Innovative Experiment/Concept Design & Implementation	10		
3	Laboratory Internal	10	Viva Voce	10
	Total Marks	50	Total Marks	50

SEMESTER: I

Course Code	:	22MCS1A1T	**Advanced Embedded Computing Devices**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective A (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Govindaraju M			

UNIT - I **9 Hrs**

Introduction to Embedded System Design
Introduction, Characteristics of Embedding Computing Applications, Concept of Real time Systems, Challenges in Embedded System Design, Design Process: Requirements, Specifications, Hardware Software Partitioning, Embedded System Architecture
Instruction Set Architectures with examples, Memory system Architecture: Caches, Virtual Memory, Memory Management, I/O sub system: Busy wait I/O, DMA, Interrupt Driven I/O, Co-Processor & Hardware Accelerators, CPU Power Consumption, Benchmarking Standards: MIPS, MFLOPS, MMACS, Coremark

UNIT - II **9 Hrs**

Designing Embedded System Hardware –I
CPU Bus: Bus Protocols, Bus Organization, Introduction to SATA,PCI, PCI-e, Memory Devices and their Characteristics: RAM, EEPROM, Flash Memory, DRAM, DDRAM; I/O Devices: Timers and Counters, Watchdog Timers, Interrupt, Controllers, DMA Controllers, A/D and D/A Converters, LED,OLED

UNIT - III **8 Hrs**

Designing Embedded System Hardware –II
Programmed IO, Memory Mapped IO, Interfacing Protocols: SPI, I2C, CAN, Reset Circuits, Designing with Processors: System Architecture, FPGA based Design, Processor Selection Criteria

UNIT - IV **8 Hrs**

Designing Embedded System Software –I
Application Software, System Software, Use of High Level Languages, Integrated Development Environment tools: Editor, Compiler, Linker, Automatic Code Generators, Debugger, Board Support Library, Chip Support Library, Embedded System Coding Standards: MISRA C 2012/CERT.

UNIT - V **8 Hrs**

Designing Embedded System Software –II
OS based Design, Real Time Kernel, Process& Thread, Inter Process Communications, Synchronization, Case Study: RTX-ARM/FreeRTOS, Evaluating and Optimizing Operating System Performance: Response time Calculation, Time Loading, Memory, Loading, Case Study: Embedded Control Applications-Software Coding of a PID Controller, PID Tuning

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

CO1	:	Interpret hardware & software of an embedded systems for real time applications with suitable processor architecture, memory and communication interface.
CO2	:	Design embedded software & hardware to meet given constraints pertaining to both operational and non-operational attributes.
CO3	:	Demonstrate the concurrent execution of different operations with the support of real time operating systems.
CO4	:	Engage in usage of tools to formulate, design and analyze different applications realized with embedded processors.

Reference Books

1. Embedded Systems – A contemporary Design Tool, James K Peckol, 2nd edition, John Weily, 2008, ISBN: 0-444-51616-6
2. Introduction to Embedded Systems, Shibu K V, 1st edition, Tata McGraw Hill Education Private Limited, 2009, ISBN: 10: 0070678790
3. Embedded Software Primer, David E.Simon, Addison Wesley, 2nd edition, John Weily, 2002, ISBN-13: 978-0201615692
4. The Intel Micro-processors, Architecture, Programming and Interfacing, Barry B.Brey, 6th Edition, Pearson Education, 2008, ISBN-10: 8131726223

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I

Course Code	:	22MCS1A2T	**Multirate Systems and Filter Banks**	CIE Marks	:	100
Credits L-T-P	:	3- 0- 0		SEE Marks	:	100
Hours	:	42L	*Elective A (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Uttarakumari M			

UNIT - I **9 Hrs**

Basics of Signals and Systems, Knowledge of Linear Algebra and Probability Theory, Fundamental Concepts of Signal Processing and Programming Skills. Fundamentals of Multirate Systems Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling Rate Conversion by a Rational Factor I/D. Implementation of Sampling Rate Conversion on DSP processor : Polyphase Filter Structures, Interchange of Filters and down samplers/Up samplers.

UNIT - II **9 Hrs**

Sampling Rate Conversion with Cascaded Integrator Comb Filters, Polyphase Structures for Decimation and Interpolation filters and Structures for Rational Sampling Rate Conversion. Multistage Implementation of Sampling Rate Conversion,Sampling Rate Conversion by an Arbitrary Factor, Digital Filter Banks.

UNIT - III **8 Hrs**

Two Channel Quadrature Mirror Filter Bank Elimination of Aliasing, Condition for perfect Reconstruction, Polyphase form of the QMF Bank, IIR QMF Bank, Perfect Reconstruction TwoChannel FIR QMF Banks in Sub band Coding, M-channel QMF Bank

UNIT - IV **8 Hrs**

The Wavelet Transform and its relation to Multirate Filter Banks Introduction, The short-Time Fourier transform, The wavelet transform, Discrete-Time orthonormal wavelets, Continuous- Time orthonormal wavelet, Time frequency analysis, Noise analysis and removal.

UNIT - V **8 Hrs**

Various Application of Filter bank in Image- processing, speech Processing using DSP processor.Use ofDCT filter Banks for JPEG image compression and modifications of sub-bands for image modifications

Course Outcomes:

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

CO1	:	Design & analyze the practical aspects of sampling and reconstruction and select a suitable sampling rate for a given signal processing problem.
CO2	:	Design & development of tree-structured maximally decimated filter bank through the concept of discrete-time wavelets.
CO3	:	Design and analyze multi-rate filters for a given specification.
CO4	:	Implement Multirate QMF, PR orthogonal filter banks and wavelet filters for various applications

Reference Books

1. Digital signal processing, Proakis and Manolakis, 3rd edition, Prentice Hall, 1996, ISBN 0131873741.

2. Modern Digital signal processing, Robert. O. Cristi, 2nd edition, Cengage Publishers, India, 2003, ISBN:978-0534400958

3. Multirate Systems and Filter Banks, Vaidyanathan P.P, 1st edition, Pearson Publication, 2006, ISBN: 81-7758-942-3S.

4. Digital signal processing: A computer-based approach, K. Mitra, 3rd edition, TMH, India, 2007, ISBN 9780070667563

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I

Course Code	:	22MVE1A3T	**VLSI Digital Signal Processing**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective A (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Abhay Deshpande			

UNIT - I **9 Hrs**

Introduction to Digital Signal Processing Systems Introduction, Typical DSP algorithms, DSP Application demands, Scaled CMOS Technologies, Representations of DSP algorithms.

UNIT - II **9 Hrs**

Pipelining and Parallel Processing Introduction, Pipelining of FIR Digital Filters, Parallel Processing, Pipelining and Parallel processing for low power using Candence tool.

UNIT - III **8 Hrs**

Algorithmic strength reduction in filters and transforms Introduction, Parallel FIR filters, Discrete Cosine Transform and Inverse DCT, Parallel Architectures for Rank-Order Filters.

UNIT - IV **8 Hrs**

Pipelined and parallel Recursive and Adaptive Filters Introduction, Combined pipelining and parallel processing for IIR filters, Low power IIR digital filter design using pipelining and parallel processing on Cadence, pipelined Adaptive Digital filter design.

UNIT - V **8 Hrs**

Programmable Digital Signal Processor Introduction, Evaluation and important features of programmable VLSI-DSP processor, application of VLSI-DSP processor in the field of Wireless Communication, Multimedia Signal Processing etc.

Course Outcomes:

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

CO1	:	Analyze DSP architectures and CMOS technologies
CO2	:	Apply pipelining, parallel processing and retiming in DSP.
CO3	:	Design pipelined and parallel recursive adaptive filters
CO4	:	Develop applications using general purpose digital signal processors

Reference Books

1. Keshab K. Parthi , “VLSI Digital Signal Processing Systems :Design and implementation” Wiley 1999, 3rd Edition, ISBN: 81-265-1098-6

2. Rulph chasseing, “Digital Signal Processing and Applications “ with C6713 and C6416 DSK, Wiley 2005, 2nd edition, ISBN: 978-0470138663

3. Nasser Kehtarnavaz, ”Digital Signal Processing System Design: Lab view based hybrid programming”, Academic press 2008, 2nd edition, ISBN: 978-0123744906.

4. Naim Dahnoun “Digital Signal Processing Implementation” Prentice Hall, 2000, ISBN: 978-0201619164

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom’s Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			*RUBRIC for SEE*		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I

Course Code	:	22MCS1B1T	**Digital System Design using HDL**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective B (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Arun Kumar P.Chavan			

UNIT - I **9 Hrs**

Introduction to Verilog and Design Methodology: Introduction to Verilog: Verilog IEEE standards, Application Areas and Abstraction levels, Need of verification of HDL design, Simulation and Synthesis, Test-benches, Verilog Data Types: Net, Register and Constant. Verilog Operators: Logical, Arithmetic, Bitwise, Reduction, Relational, Concatenation and Conditional, Number representation and Verilog ports.
Verilog Primitives. Logic Simulation, Design Verification, and Test Methodology: Four-Value Logic and Signal Resolution in Verilog, Test Methodology Signal Generators for Test benches, Event-Driven Simulation, Sized Numbers.Propagation Delay.
Introduction to Design Methodology: Digital Systems and Embedded Systems, Real-world circuits. Design Methodology: Design Flow-Architecture, Functional design and verification, Synthesis, Physical design. Design Optimization-Area, Timing and Power, System representation.

UNIT - II **9 Hrs**

Number Basics and Verilog Modelling Styles: Number Basics: Unsigned and Signed Integers, Fixed-point and Floating-point Numbers. Boolean Functions and Boolean Algebra, Verilog models for Boolean switching function, Binary Coding.
Behavioural Modelling: Latches and Level-Sensitive Circuits in Verilog, Cyclic Behavioural Models of Flip-Flops and Latches, Cyclic Behaviour and Edge Detection. A Comparison of Styles for Behavioural modelling, Behavioural Models of Multiplexers, Encoders, Decoders and Arithmetic circuits. Dataflow Modelling: Boolean Equation-Based Models of Combinational Logic, Propagation Delay and Continuous Assignments. Dataflow Models of a Linear-Feedback Shift Register. Modelling Digital Machines with Repetitive Algorithms Machines with Multicycle Operations. Tasks & Functions.
Structural Modelling: Design of Combinational Logic, Verilog Structural Models, Module Ports, Top-Down Design and Nested Modules. Gate level modelling. (Hands on using Xilinx vivado tool). High level synthesis.

UNIT - III **8 Hrs**

Synthesis of Digital Sub-systems: Synthesis of Combinational Sub-systems: Introduction to Synthesis, Synthesis of Combinational Logic, Synthesis of Sequential Logic with Latches, Synthesis of Three-state Devices and Bus Interfaces. Synthesis of Sequential Sub-systems: Synthesis of Sequential Logic with Flip-Flops, Synthesis of Explicit State Machines, Registered Logic, State Encoding, Synthesis of Implicit State Machines, Registers and Counters. (Hand on using Xilinx Vivado)

UNIT - IV **8 Hrs**

System Implementation and Fabrics: CPLD vs FPGA Architecture - Programming Technologies-Chip I/O-Programmable Logic Blocks- Fabric and Architecture of FPGA. Xilinx Virtex 5.0 Architecture - Xilinx Virtex VI Architecture – ALTERA Cyclone II Architecture - ALTERA Stratix IV Architecture, Hardcore and Softcore FPGA. (Examples such as counter, sequence detector, sequence generated etc are implemented on Airtex-7 FPGA board)

UNIT - V **8 Hrs**

Processor Design and System Development: Design of Processor Architectures: Functional Units for Addition, Subtraction and Multiplication (overview). Design: Hierarchical Decomposition STG-Based Controller Design, Efficient STG-Based Sequential Binary Multiplier.
Interfacing Concepts: Embedded Computer Organization, Instruction and Data, Memory Interfacing. I/O Interfacing: I/O devices, I/O controllers, Parallel Buses, Serial Transmission.

Course Outcomes:

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

CO1	:	Define IEEE-1364 standard and identify different styles of modelling to build digital systems.
CO2	:	Analyze digital systems and build small scale applications using Interfacing concepts.
CO3	:	Design and verify the behavior of digital circuits using digital flow
CO4	:	Demonstrate the skill on cost-effective system designs through proper selection of implementation

Reference Books

1. Advanced Digital Design With the Verilog HDL, Michael D. Ciletti, 2nd Edition, PHI, ISBN: 9789332584464, 2017.

2. Digital Design: An Embedded Systems Approach Using VERILOG, Peter J. Ashenden,Elsevier, ISBN: 8190935631, 2010.

3. Digital Systems Design Using Verilog, Charles Roth, Lizy K. John, ByeongKil Lee,Cengage Learning, ISBN: 1305120744, 2016.

4. Fundamentals of Digital Logic with Verilog Design, Stephen Brown and ZvonkoVranesic, 6th Edition, McGraw Hill publication, ISBN: 0073380547, 2013.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I

Course Code	:	22MCS1B2T	**Multimedia Communication and Networking**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective B (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Kiran V			

UNIT - I	**9 Hrs**
Multimedia Communications: multimedia information representation, multimedia networks, multimedia applications, network QoS and application QoS.	
UNIT - II	**9 Hrs**
Compression principles: lossless and lossy, Source encoders and destination decoders, Entropy encoding, Source encoding, Statistical encoding text compression- Runlength,static Huffman Coding,Dynamic Huffman coding,Arithmetic coding,LZ77,LZ78 LZW, Image compression- GIF, TIFF and JPEG.	
UNIT - III	**8 Hrs**
Audio and video compression: Introduction, audio compression, DPCM, ADPCM, APC, LPC, video compression principles.	
UNIT - IV	**8 Hrs**
Video compression standards: H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs.	
UNIT - V	**8 Hrs**
Multimedia Protocols: Introduction, IP datagrams, fragmentation, Internet protocol address, ARP and RARP, QoS. Transport Protocol: Introduction, TCP/IP, TCP, UDP, RTP and RTCP, RSVP.	

Course Outcomes:

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

CO1	:	Enumerate technical characteristics and performance of various multimedia data
CO2	:	Deploy the appropriate compression algorithm for multimedia data.
CO3	:	Apply QoS to multimedia network applications
CO4	:	Evaluate the broadband architectures and real time transport protocols

Reference Books

1. Fred Halsall, “Multimedia Communications”, 1st Edition, Pearson education, ISBN: 8131709949, 2002.

2. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “Multimedia Communication Systems”, Pearson education, ISBN:013031398X, 2002

3. Raif steinmetz, Klara Nahrstedt, “Multimedia: Computing, Communications and Applications”, Pearson education, ISBN:9788177584417, 2002

4. John Villamil, Louis Molina, “Multimedia : An Introduction”, PHI, ISBN: 1575765578,2002

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom’s Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			*RUBRIC for SEE*		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I

Course Code	:	22MCS1B3T	**Optical Communications and Networks**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective B (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Prakash Biswagar			

UNIT - I **9 Hrs**

Introduction
Overview of optical fiber communications, Basic principles of light propagation, Ray-Model, Wave-Model, Optical fiber modes, single and multi-mode fibers, single and multi-core fibers.
Transmission System Engineering
System Model, Power penalty, Transmitter, Receiver, Different optical amplifiers - SOA, EDFA.

UNIT - II **9 Hrs**

Introduction to Optical Components and Networks Optical Components - Couplers, Isolators and Circulators, Solitons, Multiplexes and Filters, Optical Amplifiers. Transmitters, Detectors, Switches, Wavelength Converters. Optical Networks - Telecommunication networks, First generation optical networks, Multiplexing techniques, Second generation optical networks, System and network evolution and Demultiplexing Techniques

UNIT - III **8 Hrs**

Optical Networks Architecture SONET/SDH, Computer interconnects, MANS, Layered architecture for SONET and second generation networks. Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols, Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM.

UNIT - IV **8 Hrs**

Wavelength Routing Networks- Optical layer, Node design, Network design and operation, routing and wavelength assignment architectural variations ,Optical Network Routing Principles - Impairment Aware Routing ,Optical Circuit Switching ,Optical Packet Switching
Optical Burst Switching, Energy Awareness in Optical Networking, Network Modelling Tools Network Design Guidelines.

UNIT - V **8 Hrs**

Virtual topology, Network Control and Management Virtual topology design problem, Combines SONET/WDM network design, an ILP formulation, Regular virtual topologies, Control and management, Network management configuration management, Performance management, fault management. Network management functions, Optical safety.

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

CO1	:	Understand the spectrum requirements and the standards used for Optical communication
CO2	:	Understand the basics of WDM Technology and various components it uses
CO3	:	Apply the knowledge to delve into contemporary applications and research in the areas of Optical communication.
CO4	:	Explore concepts of designing and operating principles of modern optical communication systems and networks

Reference Books

1. Kumar Sivarajan and Rajiv Ramaswamy, Morgan Kauffman, Optical Networks: A Practical Perspective, Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010.
2. Harry G. Parros, Communication Oriented Networks, Wiley, ISBN: 0470021632, 2005
3. G. Agrwal, Fiber Optic Communication Systems, John Wiley and Sons, 3rd Edition, New York, 2014.
4. C. Siva Ram Moorthy and Mohan Gurusamy, WDM Optical Networks: Concept, Design and Algorithms, Prentice Hall of India, 1st Edition, 2002.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	**22IM21T**	**RESEARCH METHODOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Common Course to all M.Tech Programs*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Rajeswara Rao K V S			

UNIT - I	8 Hrs
Research Problem: Problem Solving – General Problem Solving, Logical Approach, Soft System Approach, Creative Approach, Group Problem Solving Techniques for Idea Generation. Formulation of Research Problems – Approaches to Research Problem, Exploration for Problem Identification, Hypothesis Generation and Formulation of the problem.	
UNIT - II	9 Hrs
Research Design: Experimental Design – Principles of Experiment, Laboratory Experiment, Experimental Design, Quasi Experimental Design, Action. Research, Validity and Reliability of Experiment and Quasi Experiments. Ex Post Facto Research – Exploratory Research, Historical Research, Descriptive Research, Field Studies, Survey Research, Qualitative Research Methods.	
UNIT - III	8 Hrs
Research Design for Data Acquisition: Measurement Design – Primary types of Measurement scales, Validity and Reliability Measurement, Sample Design – Non-Probability Sampling, Probability Sampling. Data Collection Procedures – Sources of secondary data, Primary data collection methods, Validity and Reliability of data collection procedures.	
UNIT - IV	9 Hrs
Data Analysis: Exploratory Data Analysis, Statistical Estimation, Hypothesis Testing, Parametric Tests, Non-Parametric Tests, Multiple Regression, Factor Analysis, Cluster Analysis	
UNIT - V	8 Hrs
Research Proposal: Purpose, Types, Development of Proposal, Evaluation of Research Proposal. Report Writing: Pre-writing consideration, Format of Reporting, Briefing, Best practices for Journal writing.	

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

CO1	:	Recognize 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	:	Express research output in a structured report as per the technical and ethical standards.
CO4	:	Develop a research design for the given engineering and management problem context.

Reference Books:

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Integration of Principles, Methods and Techniques, 17th Impression, Pearson India Education Services Pvt. Ltd, 2018. ISBN: 978-81-7758-563-6

2. William M. K. Trochim, James P. Donnelly, The Research Methods Knowledge Base, 3rd Edition, Atomic Dog Publishing, 2006, ISBN: 978-1592602919

3. Kothari C.R., Research Methodology Methods and Techniques, 4th Edition, New Age International Publishers, 2019, ISBN: 978-93-86649-22-5.

4. Levin, R.I. and Rubin, D.S., Statistics for Management, 8th Edition, Pearson Education: New Delhi, 2017, ISBN-13- 978-8184957495.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE

Sl.No	Content	Marks
1	Quizzes - Q1 & Q2	20
2	Tests - T1 & T2	40
3	Experiential Learning - EL1 & EL2	40
	Total Marks	100

RUBRIC for SEE

Q. No	Contents	Marks
Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
1 & 2	Unit-1: Question 1 or 2	20
3 & 4	Unit-2: Question 3 or 4	20
5 & 6	Unit-3: Question 5 or 6	20
7 & 8	Unit-4: Question 7 or 8	20
9 & 10	Unit-5: Question 9 or 10	20
	Total Marks	100

SEMESTER: II

Course Code	:	22MCS22TL	**Advanced Communication Systems-2**	CIE Marks	:	100
Credits L-T-P	:	3-0-1	*(Theory & Practice)*	SEE Marks	:	100
Hours	:	42L + 28P	*(Professional Core - 4)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. S Ravishankar				

UNIT - I **9 Hrs**

Synthesizers - PLL Frequency Synthesizers, fractional PLL synthesizers, Direct Digital synthesizers Fading – Large scale, small scale; Statistical characterization of multipath channels – Delay and Doppler spread, classification of multipath channels, scattering function; Binary signaling over frequency non selective Rayleigh fading channel, and Frequency selective fading channel.

UNIT - II **9 Hrs**

Fading and Diversity: - Diversity techniques for performance improvement with binary signaling over FNS, Slow fading channels – power combining and Maximal ratio combining; Frequency selective channels – Rake receivers, Performance, Tap weight Synchronization.
Channel estimation and synchronization for Single and Multicarrier carrier LTE and Wi-Fi

UNIT - III **8 Hrs**

Capacity of wireless channel: A Review of Differential Entropy. Shannon's Theorem, Capacity of a Linear time invariant Gaussian channel, Capacity of Colored Noise channels. Multicarrier Signalling: Single carrier vs Multicarrier, Multicarrier Concepts, Types of Multicarrier in AWGN channel, OFDM, DMT, FBMC Implementation, Spectral Characteristics, ISI and ICI in Multicarrier, Power and bit allocation algorithms, Capacity of Multicarrier Channel, Peak to Average Power Ratio for Multicarrier, Channel Equalization and Coding Considerations for Multicarrier.

UNIT - IV **8 Hrs**

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

UNIT - V **8 Hrs**

MIMO capacity and multiplexing architectures: The V-BLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Slow fading MIMO channel, D-BLAST concepts and Considerations Receiver architectures – (MLD, MMSE, ICD and SVD), Information theoretic optimality.

LABORATORY **28 Hrs**

1. Modulation and Detection, Pulse Shaping and Matched Filtering
2. Synchronization: Symbol Timing Recovery in Narrowband channels
3. Channel Estimation & Equalization
4. Frame Detection & Frequency Offset Correction
5. OFDM Modulation & Frequency Domain Equalization
6. Synchronization in OFDM Systems using Schmidl and Cox Algorithm
7. Channel Coding in OFDM Systems
8. Generation of OFDM Signal using the 16-point QAM signal constellation.
9. Performance of AWGN and Rayleigh fading channels for different Binary modulation schemes- BPSK, BFSK, DPSK. 10. Performance improvement through Signal diversity on a Frequency non-selective channel. Performance improvement through RAKE demodulator on a Frequency selective channel.
11. Error rate Performance of 2x2 MIMO system in a Rayleigh fading AWGN channel using a) Maximum-Likelihood Detector (MLD) b) Minimum Mean-Square-Error Detector (MMSE) and c) Minimum Inverse Channel Detector (ICD)

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

CO1	:	Explain the concepts of multi-channel signaling scheme and synchronization for carrier and symbol timing recovery at receiver.
CO2	:	Evaluate the degradation in performance of various symbol signaling schemes in a multipath fading environment.
CO3	:	Develop & analyze schemes to improve performance in a multipath fading environment including diversity, maximal ratio combining and RAKE receivers.

CO4	:	Develop and evaluate the performance of a MIMO scheme to meet specified rate in a given multipath environment.

Reference Books

1. Digital Communications, John G. Proakis, Masoud Salehi, 5th Edition, Pearson Education, ISBN:9789339204792, 2014

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

3. Digital Communications: Fundamentals and Applications, Bernard Sklar,2nd Edition, Pearson Education, ISBN:9788131720929, 2009

4. Digital Communications Systems, Simon Haykin, 1st Edition, Wiley, ISBN:8126542314, 2014

Scheme of Continuous Internal Evaluation (CIE): 10 + 30 + 30 + 30 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The average of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 30 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (10), Video based seminar /presentation /demonstration (20) adding upto 30 marks.

Laboratory: Conduction of laboratory exercises, Lab report & observation & analysis (30 Marks), Lab Test (10 Marks) & Innovative Experiment/Concept Design & Implementation (10 Marks) adding up to 50 Marks. The final marks will be reduced to 30 Marks.

Scheme of Semester End Examination (SEE) for 100 marks: Each unit consists of TWO Questions of 16 Marks each. Answer FIVE full questions selecting one from each unit (from 1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.

Rubric for CIE & SEE for Integrated Theory courses with Laboratory

RUBRIC of CIE			***RUBRIC of SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	10	Each unit consists of TWO questions of 16 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.		
2	Tests - T1 & T2	30			
3	Experiential Learning - EL1 & EL2	30	1 & 2	Unit-1: Question 1 or 2	16
4	Laboratory	30	3 & 4	Unit-2: Question 3 or 4	16
	Total Marks	100	5 & 6	Unit-3: Question 5 or 6	16
NO SEE for Laboratory			7 & 8	Unit-4: Question 7 or 8	16
			9 & 10	Unit-5: Question 9 or 10	16
			11	Laboratory Component (Compulsory)	20
				Total Marks	100

SEMESTER: II

Course Code	:	22MCS23T	**Smart Antennas and Algorithms**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Professional Core - 5*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Shushrutha K S				

UNIT - I **9 Hrs**

Array, Antenna Synthesis: Introduction, Two-Element Array, N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity, Antenna Synthesis Continuous Sources, Schelkunoff Polynomial Method, Fourier Transform Method, Woodward-Lawson Method, Taylor Line-Source (Tschebyscheff Error), Triangular, Cosine, and Cosine-Squared Amplitude Distributions

UNIT - II **9 Hrs**

Array signal Modelling: Frequency-wavenumber Response, Beam Patterns, Uniform Linear Arrays, Uniformly Weighted Linear Arrays, Beam Pattern Parameters, Array Steering, Array Performance: Directivity Array Gain vs. Spatially White Noise. Characterization of Space-time Processes: Introduction, Frequency-domain Snapshot Models, Narrowband Time-domain Snapshot Models, Orthogonal Expansions, AI for non regular array antenna design.

UNIT - III **8 Hrs**

"Beamformers Optimum Beamformers: Minimum Variance Distortionless Response (MVDR) Beamformers, Minimum Power Distortionless Response (MPDR) Beamformer,Optimum LCMV and LCMP Beamformers, Generalized Side lobe Cancellers.
Adaptive Beamformers: Estimation of Spatial Spectral Matrices -Sample Spectral Matrices: Asymptotic Behaviour, Parametric Spatial Spectral Matrix Estimation, Singular Value Decomposition Sample Matrix Inversion (SMI): Recursive Least Squares (RLS): Least Squares Formulation, Recursive Implementation LMS Beam forming Algorithms"

UNIT - IV **8 Hrs**

Direction of Arrival Algorithms: Spectral Estimation Methods, Bartlett Method, Minimum Variance Distortion less Response Estimator, Linear Prediction Method, Maximum Entropy Method, Maximum Likelihood Method, Eigen structure Methods, MUSIC Algorithm, Minimum Norm Method, ESPRIT Method, Weighted Subspace

UNIT - V **8 Hrs**

Beam Forming Networks in Multiple-Beam Arrays: Introduction, BFN Using Power Dividers, Butler Matrix Beam Former, Fourier Transform and Excitation Coefficients, FFT Algorithm, FFT and Butler Matrix, Hybrid Matrix, Modified Butler BFN for Nonuniform Taper, Digital Beam Former, Digital Phase Shifter, System Characteristics, Active Array Block Diagrams, Aperture Design of Array, Number of Elements and Element Size, Radiating Element Design Consideration.

Course Outcomes:

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

CO1	:	Apply the concept of spatial spectrum of a planar array antenna to understand the estimation process for a spatially distributed statistical signal being received by the antenna.
CO2	:	Analyse appropriate complex weighting technique for array elements that provide desirable spatial response and beam pattern.
CO3	:	Analyse the spatially sampled spectrum by an array and verify the performance of known spatial estimation algorithms.
CO4	:	Evaluate and develop an array with spatial estimation algorithms that meet a specified spatial performance requirement including resolution and SNR.

Reference Books

1. Optimum Array Processing: Part IV of Detection, Estimation, and Modulation Theory, Harry L. Van Trees, John Wiley & Sons, ISBN: 9788126538478, 2002

2. Antenna Theory: Analysis and Design, Constantine A. Balanis, 3rd Edition, John Wiley & Sons, ISBN: 9788126524228, 2009

3. Phased Array Antennas: Floquet Analysis, Synthesis, BFNs and Active Array Systems, Arun K. Bhattacharyya, Wiley-Interscience; 1st edition, ISBN: 0471727571, 2006

4. Array Signal Processing: Concepts and Techniques, Don H. Johnson, Dan E. Dugeon, Prentice Hall Signal Processing Series. ISBN: 0130485136, 1993

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	22MCS2C1T	**Development of Modem SoCs for Wireless, Wireline and IOT applications**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42 L	*Elective C (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. S Ravishankar				

UNIT - I	**9 Hrs**
Algorithms for single carrier communications and Multicarrier Communication modems, Algorithms for MIMO Applications, Single carrier Channel estimation for DSL , Wi-Fi and cellular standards	
UNIT - II	**9 Hrs**
DSL standards for Transreceiver, Synchronization, Channel estimation, Mapping standards to Modem SoC hardware and firmware, DSL standards for Testing, Simulation in Matlab and C of specific modules and assignment in Zynq board	
UNIT - III	**8 Hrs**
802.11 standards for Transreceiver, Synchronization, Channel estimation, Mapping standards to Modem SoC hardware and firmware, 802.11 standards for Testing, Simulation in Matlab and C of specific modules and assignment in Zynq board, IEEE 802.15.4 standard	
UNIT - IV	**8 Hrs**
LTE standards for Transreceiver, Synchronization,Channel estimation, Protocol Stacks, Mapping standards to Modem SoC hardware and firmware , LTE standards for Testing, Simulation in Matlab and C of specific modules and assignment in Zynq board	
UNIT - V	**8 Hrs**
Development Life Cycle for a Modem, Three case studies of SoC for Modem Implementation. Scenarios for Mobility management in networks, Session initialization management and in-service monitoring in networks, IOT Applications	

Course Outcomes:

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

CO1	:	Explain the concepts of synchronization and channel estimation algorithms for DSL, WiFi and LTE.
CO2	:	Associate the standards sections to Training, Initialization and show time with in-service monitoring algorithms
CO3	:	Recognize typical SoC platforms in terms of their hardware and software capabilities to implement algorithms with task scheduling.
CO4	:	Develop runtime code to evaluate performance of a training, Initialization and showtime on the typical SoCs.

Reference Books

1. ITU-T TELECOMMUNICATION STANDARDIZATION SECTOR , “Asymmetric digital subscriber line transceivers 2 (ADSL2) G.992.3 , April 2009.

2. IEEE Standard for Information Technology Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks— Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, IEEE Std 802.11™-2020

3. European Telecommunications Standards Institute (ETSI), “ 5G; NR;Base Station (BS) radio transmission and reception (3GPP TS 38.104 version 16.4.0 Release 16)”, July 2020

4. ADSL: Standards, Implementation, and Architecture, by Charles K. Summers
CRC Press, CRC Press LLC, ISBN: 084939595x Pub Date: 06/21/99

5. System Architecture Documents (for two cases TI and Centillium)

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	22MDC2C1T	**RF and Microwave Circuit Design for Wireless Communication Systems**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	***Elective C (Professional Elective)***	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Mahesh A				

UNIT - I	**9 Hrs**
Introduction: Radio frequency and Microwave circuit applications, component basics, Transmission Lines, Microstrip line, Formulation and properties of S-parameters. Applications of Smith chart Impedance Matching networks: Goal of impedance matching, Components for matching, Design of Matching Networks - Matching network design using Lumped elements, Design of Matching Networks using Distributed Elements - Transmission lines, Microstrip lines. Wideband & Narrowband Matching circuit design. Case Studies on IC device matching, Antenna Matching	
UNIT - II	**9 Hrs**
Couplers and Power dividers - Basic properties, Types, Wilkinson Powerdivider- equal and unequal types, 90° Hybrids couplers, Directional Couplers, Circulators/Isolators. RF Filters: Basic filter configurations, Important Concepts on Filter Realizations, Filter Implementation, Lumped Filter Design, Distributed Filter Design, Microstrip line Filters, Hairpin, Edge-Coupled Filter.	
UNIT - III	**8 Hrs**
Active RF Components: RF diodes -Schottky diode, PIN diode, Varactor diode, Bipolarjunction transistor - RF field effect transistors, metal oxide semiconductor transistors, High electron mobility transistors, (construction, functionality, frequency response), Microwave Amplifier-I: Amplifier classes of operation and biasing networks, characteristic of amplifiers, Amplifier power relations, stability considerations, and constant gain Circles and Noise figure circles	
UNIT - IV	**8 Hrs**
Microwave Amplifier-II: Broadband amplifiers, High power amplifiers, Multistage amplifiers, Low noise amplifiers. Oscillators: Basic oscillator models - Feedback oscillator, Negative Resistance oscillator, oscillator phase noise, feedback oscillator design, design steps, High frequency oscillator configuration-Dielectric Resonator oscillators, and Voltage controlled oscillator. Introduction to Frequency synthesizer.	
UNIT - V	**8 Hrs**
Mixers: Basic consideration of Mixers- basic concepts, frequency domain considerations, single ended mixer design, Balanced (single & Double) mixers, Integrated active mixers and image reject mixer. Control Circuits: Switch, Phase Shifters, Attenuators RF Front-end / Subsytem Design Fundamental Concepts & Performance Parameters / Measurements Case Study- RF transceiver Design (T/R-Module)	

Course Outcomes:

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

CO1	:	Review the concepts of RF components and circuits, smith charts, RF subsystems.
CO2	:	Analyze the performance parameters of RF passive components.
CO3	:	Design RF active circuits for given specifications.
CO4	:	Evaluate the Performance of RF passive and active circuits through simulation tools.

Reference Books

1. RF circuit design, theory and applications, Reinhold Ludwig, Pavel Bretchko, 2nd Edition, Pearson Asia Education, ISBN: 9788131762189, 2011

2. Mathew M. Radmanesh, “Radio Frequency and Microwave Electronics”, Pearson Education Asia, ISBN : 9780130279583,2001

3. Microwave Engineering, D. Pozar, John Wiley & Sons, 4th edition, New York.: ISBN: 8126541903, 2013

4. Microwave Transistor Amplifiers: Analysis and Design, Guillermo Gonzalez, Pearson; 2nd edition, ISBN:0132543354 ,1996

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	22MVE2C3T	**Robotics and Industrial Automation**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective C (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Abhay Deshande			

UNIT - I **9 Hrs**

"Introduction: Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, the Wrist & Gripper Subassemblies.
Kinematics of Robot Manipulator: Introduction, General Mathematical Preliminaries on Vectors& Matrices, Direct Kinematics problem, Geometry Based Direct kinematics problem, Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Problems."

UNIT - II **9 Hrs**

"Trajectory Planning: – Introduction, Trajectory Interpolators, Basic Structure of TrajectoryInterpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories:- 4-3-4 & 3-5-3 Trajectories. (SLE: Admissible Motion Trajectories) Dynamics of Robotic Manipulators: Introduction,. Preliminary Definitions, GeneralizedRobotic Coordinates, Jacobian for a Two link Manipulator, Euler Equations, TheLagrangian Equations of motion."

UNIT - III **8 Hrs**

Robot Sensing & Vision: Various Sensors and their Classification, Use of Sensors and SensorBased System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors. Industrial Applications: Objectives, Automation in Manufacturing, Robot Application in Industry, Task Programming, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges and Case Studies. (SLE: Goals of AI Research, AI Techniques)

UNIT - IV **8 Hrs**

Modeling and control: Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators. Overview of PLC Hardware, numeric data handling, system addressing, and programming software. Robot Manipulator Control Using PLC with Position Based and Image Based Algorithm. Case Study.

UNIT - V **8 Hrs**

"Programmable Digital Signal Processor Introduction, Evaluation and important features of programmable VLSI-DSP processor, application of VLSI-DSP processor in the field of Wireless Communication, Multimedia Signal Processing etc. "

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

CO1	:	Analyze the process Modeling hierarchies, theoretical and empirical models.
CO2	:	Apply different Feedback & feed forward control techniques for theoretical and empirical models.
CO3	:	Comprehend the Decoupling controller, Instrumentation for process monitoring and preparation of P&I diagrams
CO4	:	Develop Statistical process control, supervisory control, direct digital control, distributed control, PC based automation.

Reference Books

1. Fu, Lee and Gonzalez , “Robotics, control vision and intelligence”. McGraw Hill International, 2007,2nd edition, ISBN: 978-0071004213.
2. John J. Craig, “Introduction to Robotics”- Addison Wesley Publishing, 2010, 3rd edition, ISBN: 978-0201543612
3. Ghosal A, “Fundamental concepts and Analysis”, Oxford University Press2008, 2nd edition, ISBN: 978-0195673913
4. Sebastian Thrun, “Probabilistic Robotics”, The MIT Press, 2005, 2nd edition, ISBN:978-0262201629

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

Semester: II						
ADVANCED 5G						
Course Code	**:**	22MCS2C4T		**CIE**	**:**	100Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	36		**SEE Duration**	**:**	3Hours
Faculty Coordinator: Dr. Nethravathi K A						

Unit-I	**8Hrs**
Introduction of Wireless Communications: Introduction to 3GPP Specs. Introduction to wireless communications; Evolution: 1G, 2G, 3G, 4G and 5G. Fundamentals of mm Wave and cm Wave. List of 3GPP. Road map for 5G. **4th Generations:** Basics to Advanced LTE concepts. History and Futures of wireless communications. Multiple access, Duplexing techniques. Functionality of SIM. Access and Non-Access Stratum, LTE Evaluation and network architecture, Interfaces, Basics of eNB, MME, gateway, policy and charging rules, HSS, User plane and Control Plane, LTE protocol stack. LTE mobility, definition of cell, tracking area, cell identifications, NAS procedures, EMM and ESM procedure. EMM and RRC states. UE Identifiers. LTE use cases and features, Carrier aggregation, multiple antenna techniques, support of relay nodes. LTE with MIMO.	
Unit – II	**07 Hrs**
5G Fundamentals Use cases of 5G: Use cases of 5G as per standards, example eMBB, mMTC, URLLC,V2X.Network Architecture; Reference Point System Architecture, Service Based System Architecture and Network Functions. **5G Fundamentals Base Station:** Base Station Architecture, CU-DU Split Base Station and CP-UP, Standalone Base Station and Non-Standalone Base Station. Basics of antennas in bases stations and Base station classes; Antenna Architecture basics and Base Station Classes. **Network Interfaces**: Xn interface, F1 interface, E1 interface, NG interface and X2 interface. **Protocol stack:** Protocol Stacks, User Plane and Control Plane.	
Unit –III	**07 Hrs**
RRC states: RRC Idle, RRC Connected and RRC Inactive. **Call Management in NR & 5G Signalling:** Call Management; Registration Management, Connection Management, Access Control. **5G Signalling;** Signalling Radio Bearers, PDU Sessions, QoS MIMO & Beam: Introduction to MIMO and Beam forming, ABF, DBF. Beam Types Analog, digital and hybrid beamforming.	
Unit –IV	**07 Hrs**
5G Beamforming Antenna: Active Antenna, Passive Antenna, polarisations, what is an Antenna, Antenna arrays. Power Splitter fundamentals, Antenna Basics – Dipole, Antenna arrays **5G Beamforming L1 Concepts**: SS/PBCH based Beamforming Codebook based Beamforming SRS based Beamforming Eigenmode Beamforming **5G Beamforming Functionality**: Static Beamforming Dynamic Beamforming – Beam Steering Dynamic Beamforming – Beam Switching Digital Beamforming vs. Analog Beamforming Pilot Signals	
Unit –V	**07 Hrs**
5G Beamforming Massive MIMO, SU MIMO and MU MIMO: Spatial Multiplexing Spatial Multiplexing vs Beamforming. Creating a Beam. Narrow Beams and Beam Steering Massive MIMO Antennas. MIMO in a Handset. Multiple Panel Antenna. Beam	

Forming Evolution Massive MI MO vs SU-MIMO vs. MU-MIMO. **5G Beamforming Principle:** Beamforming Principle DL MU-MIMO SRS based Downlink MU-MIMO Definition of basic sets of SSB Azimuthal angle

Course Outcomes: After completing the course, the students will be able to	
CO1:	Illustrate the fundamental concepts of various technologies in wireless which are used in Communication systems.
CO2:	Derive the solution by applying the acquired knowledge of wireless technologies
CO3:	Evaluate the solution of the problems using wireless techniques to the real-world problems arising in many practical situations
CO4:	Design and development of wireless techniques for 5G communication and gain knowledge to apply and engage in life – long learning.

Reference Books	
1.	Long Term Evolution IN BULLETS, by Chris Johnson 2nd Edition, July 2012, ISBN-13 : 978-1478166177.
2.	5G New Radio IN BULLETS by Chris Johnson, Independently published 2019, ISBN, 1077484356, 9781077484351.
3.	Wireless Communications: From Fundamentals to Beyond 5G,Andreas F. Molisch ,IEEE Press 3rd Edition 2022. ISBN 10: 1119117208, ISBN 13: 9781119117209.
4.	RF Antenna Beam Forming: Focusing and Steering in Near and Far Field. Shun-Ping Chen and Heinz Schmiedel,1st Edition ,2023, ISBN-13:978-3031217647.
5.	Massive MIMO Systems Kazuki Maruta and Francisco Falcone ,Mdpi AG, 3rd July 2020,ISBN-10 : 3039360167, ISBN-13:978-3039360161

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100 **QUIZZES:** Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks. **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks. **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22BT2D01T	**BIOINSPIRED ENGINEERING**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hr
Faculty Coordinator:		Dr Nagashree Rao and Dr Ashwani Sharma				

UNIT - I **8 Hrs**

Introduction to Bio-inspired Engineering: Macromolecules, Stem cells; types and applications. Synthetic Biology; Bottom-up' and 'top-down' engineering approaches. Synthetic/ artificial life. Biological Clock, Genetic Algorithms.

UNIT - II **9 Hrs**

Principles of bioinspired materials: Biological and synthetic materials, Self-assembly, hierarchy and evolution. Biopolymers, Bio-steel, Bio-composites, multi-functional biological materials. Thermal Properties. Antireflection and photo-thermal biomaterials, Microfluidics in biology, Invasive and non-invasive thermal detection inspired by skin

UNIT - III **9 Hrs**

Lessons from Nature:Bioinspired Materials and mechanism: Firefly-Bioluminescence, Cockleburs –Velcro, Lotus leaf - Self-cleaning materials, Gecko - Gecko tape, Whale fins - Turbine blades, Box Fish / Bone - Bionic car, Shark skin - Friction reducing swim suits, Kingfisher beak - Bullet train, Coral - Calera cement, Forest floor / Ecosystem functioning - Flooring tiles, Morpho butterfly- Structural color, Namib beetle- Water collecting, Termite mound passive cooling, Birds/Insects-flights/ aerodynamics, Mosquito inspired micro needle.

UNIT - IV **8 Hrs**

Biomedical Inspiration-Concept and applications: Organ system- Circulatory- artificial blood, artificial heart, pacemaker. Respiratory- artificial lungs. Excretory- Artificial kidney and skin. Artificial Support and replacement of human organs: artificial liver and pancreas. Total joint replacements- artificial limbs. Visual prosthesis -artificial eye/ bionic eye.

UNIT - V **8 Hrs**

Biomimetics: Inventions in nature for Human Innovation: Photosynthesis and Photovoltaic cells, Bionic/Artificial leaf. Bio-ink and 3D-Bioprinting. Cellular automata. Biosensors: Artificial tongue and nose. Biomimetic echolation. Insect foot adaptations for adhesion. Thermal insulation and storage materials. Bees and Honeycomb Structure. Artificial Intelligence, Neural Networking and bio-robotics.

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

CO1	:	Elucidate the concepts and phenomenon of natural processes
CO2	:	Apply the basic principles for design and development of bioinspired structures
CO3	:	Analyse and append the concept of bio-mimetics for diverse applications
CO4	:	Designing technical solutions by utilization of bio-inspiration modules.

Reference Books:

1. D. Floreano and C. Mattiussi, Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, 1st edition, MIT Press, 2008, ISBN: 9780262062718

2. Guang Yang, Lin Xiao, and Lallepak Lamboni. Bioinspired Materials Science and Engineering. 1st edition, John Wiley, 2018, ISBN: 978-1-119-3903362

3. M.A. Meyers and P.Y. Chen. Biological Materials, Bioinspired Materials, and Biomaterials, 1st edition, Cambridge University Press, 2014, ISBN 978-1-107-01045.

4. Tao Deng. Bioinspired Engineering of Thermal Materials, 1st edtion, Wiley-VCH Press, 2018. ISBN: 978-3-527-33834-4.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22BT2D02T	**HEALTH INFORMATICS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr A H Manjunatha Reddy				

UNIT - I	**8 Hrs**
Introduction, Healthcare data, information and knowledge: Data types, data conversion, clinical data warehouse, data analytics, challenges, role of informatics in analytics, future trends	
UNIT - II	**8 Hrs**
Electronic health records: Introduction, scope for the e health records, challenges, examples, logical steps to selecting and implementing EHR	
UNIT - III	**8 Hrs**
Data standards and medical coding: Introduction, medical content standards, termonology standards, transport standards, medical coding and reimbursement, future trends,	
UNIT - IV	**9 Hrs**
Healthcare Enterprise: Overview of Health Informatics: Introduction, Key players in HI, organizations involved, barriers, programs, organizations and career, HI Resoruces	
UNIT - V	**9 Hrs**
Health Information privacy and security: Introduction, basic security principles, authentication and identity management, data security in the cloud and client/server management	

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

CO1	:	Understand the basic principles of Health informatics
CO2	:	Data capture to data transformation and to analysis
CO3	:	Creation of E health records, identify the challenges
CO4	:	Improvise the significant factors as per the spatio-temporal requirements

Reference Books:

1. Robert E. Hoyt Ann K. Yoshihashi, Health Informatics, Practical guide for Healthcare and Information Technology Professionals, 6th edition, Informatics Education, 2014, ISBN: 978-0-9887529-2-4
2. Kathryn J. Hannah Marion J. Ball, Health Informatics, Springer Series edition, Springer, 2005, ISBN: 1-85233-826-1
3. William R Hersh, Health Informatics, a Practical guide, 8th edition. 2022, ISBN 978-1-387-85475-2
4. Pentti Nieminen. Medical informatics and data analysis 1st edition, MDPI AG, 2021, ISBN-13 : 978-3036500980

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

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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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22CS2D03T	**BUSINESS ANALYTICS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Azra Nasreen and Dr. Badarinath K				

UNIT - I	**9 Hrs**
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	**9 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	**8 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	**8 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	**8 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	:	Apply the concepts and methods of business analytics to solve business problems
CO2	:	Analyse, model and solve decision problems in different settings
CO3	:	Interpret results/solutions and identify appropriate courses of action for a given business scenario
CO4	:	Demonstrate skills like investigation, effective communication, working in team/Individual and following ethical practices by implementing solutions to decision making problems

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, |DOI:10.1002/9781118983881,1st Edition 2014, ISBN:978111898388
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, ISBN: 978-1-118-17556-9 .

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QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
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EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
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			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II							
Course Code	:	22CV2D04T	**INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr.V.AnanthaRam				

UNIT - I **08Hrs**

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 **09Hrs**

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 **09Hrs**

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 **08 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 **08 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 going through 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.

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Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
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1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
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			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22CV2D05T	**INTELLIGENT TRANSPORTATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr.Sunil S			

UNIT - I	**8 Hrs**
Introduction: –Historical Background, Definition, Future prospectus, ITS training and educational needs. Fundamentals of Traffic Flow and Control- Traffic flow elements, Traffic flow models, Shock waves in Traffic streams, Traffic signalization and control principles, Ramp metering, Traffic simulation	
UNIT - II	**9 Hrs**
ITS User services-User services bundles, Travel and Traffic management, Public Transportation Operations, Electronic Payment, Commercial Vehicles Operations, Emergency Management, Advanced Vehicle Control and safety systems, Information Management, Maintenance and construction Management. ITS Architecture-Regional and Project ITS Architecture, Need of ITS architecture, concept of Operations, National ITS Architecture, Architecture development tool	
UNIT - III	**9 Hrs**
Technology Building Blocks for ITS-Introduction, Data acquisition, Communication Tools, Data Analysis, and Traveller Information. Various detection, identification and collection methods for ITS. ITS Applications and their benefits-Freeway and incident management systems, Advanced arterial traffic control systems, Advanced Public Transportation Systems, Multimodal Traveller Information systems	
UNIT - IV	**8 Hrs**
ITS Planning-Transportation planning and ITS, Planning and the National ITS Architecture, Planning for ITS, Integrating ITS into Transportation Planning, relevant case studies. ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing	
UNIT - V	**8 Hrs**
ITS Evaluation – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines, Challenges and Opportunities. ITS for Law Enforcement: Introduction, Enhance and support the enforcement traffic rules and regulations, ITS Funding options and ITS case studies	

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

CO1	:	Identify and apply ITS applications at different levels
CO2	:	Illustrate ITS architecture for planning process
CO3	:	Examine the significance of ITS for various levels
CO4	:	Compose the importance of ITS in implimentions

Reference Books:

1. Pradip Kumar Sarkar and Amit Kumar Jain, “Intelligent Transport Systems”, PHI Learning Private Limited, Delhi,2018, ISBN-9789387472068

2. Choudury M A and Sadek A, “Fundamentals of Intelligent Transportation Systems Planning” Artech House publishers (31 March 2003); ISBN-10: 1580531601

3. Bob Williams, “Intelligent transportation systems standards”, Artech House, London, 2008. ISBN-13: 978-1-59693-291-3

4. Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio Garcia Zuazola “Intelligent Transport Systems: Technologies and Applications” Wiley Publishing ©2015, ISBN:1118894782 9781118894781

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom’s Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22EC2D06T	**ELECTRONIC SYSTEM DESIGN**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Prof. Ravishankar Holla				

UNIT - I **9 Hrs**

Design Process & its Fundamentals: Life Cycle of Electronic Products, Design and Development Process, Guidance for Product Planning, Design and Development, Technical Drawings, Circuit Diagrams, Computer-Aided Design (CAD)

UNIT - II **9 Hrs**

System Architecture and Protection Requirements: Introduction - Terminology, Functions and Structures, Systems Design Architecture, Electronic System Levels, System Protection
Experiential Learning: (4 quizzes on the below mentioned topics other than CIE) Reliability Analysis: Introduction, Calculation Principles, Exponential Distribution, Failure of Electronic, Components, Failure of Electronic Systems, Reliability Analysis of Electronic Systems, Recommendations for Improving Reliability of Electronic Systems

UNIT - III **8 Hrs**

Thermal Management and Cooling: Introduction - Terminology, Temperatures and Power Dissipation, Calculation Principles, Heat Transfer, Methods to Increase Heat Transfer, Application Examples in Electronic Systems, Recommendations for Thermal Management of Electronic Systems, Cooling systems, liquid, air and non cooling systems.

UNIT - IV **8 Hrs**

Electromagnetic Compatibility (EMC):
Introduction, Coupling Between System Components, Grounding Electronic Systems, Shielding from Fields, Electrostatic Discharge (ESD), Recommendations for EMC-compliant Systems Design

UNIT - V **8 Hrs**

Recycling Requirements and Design for Environmental Compliance: Introduction - Motivation and the Circular Economy, Manufacture, Use, and Disposal of Electronic Systems in the Circular Economy, Product Recycling in the Disposal Process, Material Recycling in the Disposal Process, Design and Development for Disassembly, Material Suitability in Design and Development, Recommendations for Environmentally Compliant Systems

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

CO1	:	Realize the fundamentals of Design, Architecture, thermal management, EMC and Recycling requirements of Electronic System Design
CO2	:	Analyze the various application wise design requirements in Electronic systems along with the related concepts of implementations, standards and Compliances.
CO3	:	Use modern open source tools to realize the various concepts of Electronic system design
CO4	:	Engage in self-study through assignments, simulations, case studies and projects

Reference Books:

1. Fundamentals of Electronic Systems Design, Jens Lienig, Hans Brümmer 2017, Springer International Publishing, ISBN 978-3-319-55839-4, DOI:10.1007/978-3-319-55840-0
2. “Embedded System Design”, Marwedel, Peter, Springer Nature, 10.1007/978-3-030-60910-8
3. “Electromagnetic Compatibility Engineering”, Henry W. Ott, WILEY Publication, ISBN: 978-0-470-18930-6
4. "Handbook of Electronic Systems Design" by Charles A. Harper, McGraw-Hill Inc.,US , 0070266832, 978-0070266834

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom’s Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22EC2D07T	**EVOLUTION OF WIRELESS TECHNOLOGIES**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Mahesh A				

UNIT - I	**9 Hrs**
Introduction to cellular systems: Overview of Cellular Systems and evolution 2G/3G/4G/5G, Cellular Concepts – Frequency reuse, Co channel and Adjacent channel Interference, C/I, Handoff, Blocking, Erlang Capacity, Bluetooth, WiFi, WWAN and PAN.	
UNIT - II	**9 Hrs**
Fundamentals of wireless communication: Wireless Channel, Wireless propagation, Link budget, Free-space path loss, Noise figure of receiver, Multipath fading, Shadowing, Fading margin, Shadowing margin, Wireless Channel Capacity, OFDM and LTE, Large Scale Propagation effects and Channel Models	
UNIT - III	**8 Hrs**
Fundamentals of 5G architecture: Difference between 4G and 5G, 5G Architecture, Planning of 5G Network, Quality of Service, Radio Network, Requirements, Security, SIM in 5G Era, Specifications, Standardization, Terminal States	
UNIT - IV	**8 Hrs**
mmWave and Visible Light Communications: Back ground and concept of mmWave Communications, Frequency bands, propagation characteristics, channel models, applications and challenges in 5G	
UNIT - V	**8 Hrs**
Future Generations: Future Generations(where is the 6G?), Health Considerations, Identifiers, Interfaces, ,Key Derivation, Location Based Services, Massive Internet of Things, Measurements, Network Functions Virtualization, Network Slicing, Open Source, , User Equipment, Vehicle-to-Vehicle communications (V2V),Virtual Reality (VR/AR/XR). Case study- Bharath Stack	

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

CO1	:	Demonstrate their understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards
CO2	:	Compare different technologies used for wireless communication systems.
CO3	:	Demonstrate an ability explain recent techniques for Wireless Communication systems
CO4	:	Update the latest trends in wireless communications

Reference Books:

1. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, Pearson, 2nd Edition.
2. Aditya K Jagannatham, “Principles of Modern Wireless Communications”, McGraw Hill, 2017
3. Robin Chataut, Robert Akl, “Massive MIMO Systems for 5G and beyond Networks—Overview, Recent Trends, Challenges, and Future Research Direction” Sensors, May 2020
4. A. N. Uwaechia and N. M. Mahyuddin, A Comprehensive Survey on Millimeter Wave, Communications for Fifth-Generation Wireless Networks: Feasibility and Challenges, in IEEE, Access, vol. 8, pp. 62367-62414, 2020

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom’s Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22ET2D08T	**TRACKING AND NAVIGATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Prof. Shambulinga .M, Dr. B. Roja Reddy			

UNIT - I	**9 Hrs**
An Introduction to Radar: Basic Radar, The simple form of the Radar Equation, Radar Block Diagram, Radar Frequencies, Application of radar, Types of Radars. Detection of signals in Noise, Receiver Noise and the Signal-to Noise Ratio, Probability of Detection and False alarm, Introduction to Doppler, MTI, UWB Radars	
UNIT - II	**8 Hrs**
Terrestrial Network based positioning and navigation: General Issues of wireless positions location, Fundamentals, positioning in cellular networks, positioning in WLANs, Positioning in Wireless sensor networks.	
UNIT - III	**8 Hrs**
Satellite-based navigation systems: Global Navigation satellite systems (GNSS), GNSS receivers.	
UNIT - IV	**9 Hrs**
LiDAR: Introduction to LiDAR, context and conceptual discussion of LiDAR, Types of LiDARS, LiDARS Detection modes, Flash LiDAR versus Scanning LiDAR, Monostatic versus Bistatic LiDAR, Major Devices in a LiDAR, LiDAR remote sensing, Basic components and physical principles of LiDAR, LiDAR accuracy and data formats.	
UNIT - V	**8 Hrs**
SONAR: Underwater acoustics, applications, comparison with radar, submarine detection and warfare, overcoming the effects of the ocean, sonar and information processing.Transmission of the acoustic signal: Introduction, detection contrast and detection index, transmission equation, equation of passive and active sonar.	

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

CO1	:	Understand the concepts of Radar, LiDAR, Sonar, terrestrial and satellite based navigation system
CO2	:	Apply the concepts of radars, LiDAR, Sonar, cellular networks, WLAN, sensor networks and satellites in determining the user position and navigation.
CO3	:	Analyze the different parameters of satellite and terrestrial networks for navigation systems.
CO4	:	Evaluate the Radar, LiDAR, Sonar systems and satellite and terrestrial network based navigation and tracking systems

Reference Books:

1. M. L Skolnik,Introduction to RADAR Systems,3rd edition, 2017,TATA Mcgraw-Hill, ISBN: 978-0070445338
2. Mark A Richards, James A Scheer, William A Holam,Principles of Modern Radar Basic Principles, 2010, 1st edition,SciTech Publishing Inc, ISBN:978-1891121524 .
3. Davide dardari, Emanuela Falletti, Marco Luise, Satellite and Terrestrial Radio Positioning techniques- A signal processing perspective, 1st Edition, 2012, Elsevier Academic Press, ISBN: 978-0-12-382084-6.
4. Paul McManamon,LiDAR Technologies and Systems, SPIE press, 2019.
5. Pinliang Dong and Qi Chen,LiDAR Remote Sensing and Applications, CRC Press, 2018, ISBN: 978-1-4822-4301-7
6. Jean-Paul Marage, Yvon Mori, Sonar and Underwater Acoustics, Wiley, 2013, ISBN: 9781118600658

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22IM2D09T	**PROJECT MANAGEMENT**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Vikram N Bahadurdesai				

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

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22IS2D10T	**DATABASE AND INFORMATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Prof.Smitha G R				

UNIT - I	**8 Hrs**
Advanced Database Models, Systems, and Applications : Enhanced Data Models: Introduction to Active, Temporal, Spatial, Multimedia, and Deductive Databases . Distributed Database Concepts : Distributed Database Concepts, Data Fragmentation, Replication, and Allocation Techniques for Distributed Database Design, Overview of Concurrency Control and Recovery in Distributed Databases	
UNIT - II	**8 Hrs**
Introduction to Information Retrieval and Web Search : Information Retrieval (IR) Concepts Retrieval Models, Types of Queries in IR Systems , Text Preprocessing , Inverted Indexing, Evaluation Measures of Search Relevance ,Web Search and Analysis, Trends in Information Retrieval .	
UNIT - III	**8 Hrs**
Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues, Ethical and Social issues in Information Systems: Understanding ethical and Social issues related to Information Systems, Ethics in an information society, The moral dimensions of information society. A Case study on business planning.	
UNIT - IV	**9 Hrs**
Achieving Operational Excellence and Customer Intimacy: Enterprise systems, Supply chain management(SCM) systems, Customer relationship management(CRM) systems, Enterprise application. E-commerce: Digital Markets Digital Goods: E-commerce and the internet, E-commerce-business and technology, The mobile digital platform and mobile E-commerce, Building and E-commerce web site. A Case study on ERP.	
UNIT - V	**9 Hrs**
Managing Knowledge: The knowledge management landscape, Enterprise-wide knowledge management system, Knowledge work systems, Intelligent techniques. Enhancing Decision Making: Decision making and information systems, Business intelligence in the enterprise. Business intelligence constituencies. Building Information Systems: Systems as planned organizational change, Overview of systems development.	

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

CO1	:	Understand the different models for Infromation Retrieval.
CO2	:	Appricieate the technology of Information Retrieval and Web Search
CO3	:	To understand the basic principles and working of information technology.
CO4	:	Describe the role of information technology and information systems in business.

Reference Books:

1. Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, Pearson Education, 14th Global edition, 2016, ISBN:9781292094007.
2. Fundamentals of Database Systems, Ramez Elmasri, Shamkant B. Navathe, 7th Edition, 2016, Published by Pearson, Copyright © , ISBN-10: 0133970779
3. James A. O' Brien, George M. Marakas: Management Information Systems, Global McGraw Hill, 10th Edition, 2011, ISBN: 978-0072823110.
4. Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2003, McGraw-Hill, ISBN: 9780071231510

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			RUBRIC for SEE		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II							
Course Code	:	22IS2D11T	**MANAGEMENT INFORMATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Prof. Vanishree K				

UNIT - I	**8 Hrs**
Overview: Introduction: Professional Software Development, Software Engineering Ethics, Case studies. Software Processes: Models, Process activities, Coping with Change, Process improvement. The Rational Unified Process. Computer Aided Software Engineering. Agile Software Development: Introduction to agile methods, Agile development techniques, Agile project management and scaling agile methods. Information Systems in Global Business Today: The role of information systems in business today, Perspectives on information systems, Contemporary approaches to information systems	
UNIT - II	**9 Hrs**
Requirements Engineering and System Modeling: Software Requirements: Functional and Non-functional requirements. Requirements Elicitation, Specification, Validation and Change. System Modeling: Context models, Interaction models, Structural models, Behavioural models, Model driven architecture. Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues	
UNIT - III	**9 Hrs**
Development and Testing: Design and implementation: Object oriented design using UML, Design patterns, Implementation issues, Open-source development. Software Testing: Development testing, Test-driven development, Release testing, User testing. Securing Information Systems: System vulnerability and abuse, Business value of security and control, Establishing framework for security and control, Technology and tools for protecting information resources. A case study on cybercrime.	
UNIT - IV	**8 Hrs**
Advanced Software Engineering: Dependable systems: Dependability properties, Sociotechnical systems, dependable processes, formal methods and dependability, A15 Availability and reliability, reliability requirements, Reliability measurements E-commerce: Digital Markets Digital Goods: E-commerce and the internet, E-commerce-business and technology, A Case study on ERP.	
UNIT - V	**8 Hrs**
Software Management: Project Management: Risk Management, Managing People, Teamwork, Project Planning: Software Pricing, Plan driven development, Project Scheduling, Agile planning, Estimation Techniques, COCOMO cost modeling. Building Information Systems: Systems as planned organizational change, Overview of systems development.	

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

CO1	:	Understand and apply the fundamental concepts of software engineering for information systems.
CO2	:	Develop the knowledge about software engineering for management of information systems.
CO3	:	Interpret and recommend the use information technology to solve business problems.
CO4	:	Apply a framework and process for aligning organization's IT objectives with business strategy.

Reference Books:

1. Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, Pearson Education, 14th Global edition, 2016, ISBN:9781292094007.
2. Ian Sommerville,— Software Engineering, 9th Edition, Pearson Education, 2013, ISBN: 9788131762165
3. W.S. Jawadekar: Management Information Systems, Tata McGraw Hill, 2006, ISBN: 9780070616349.
4. James A. O' Brien, George M. Marakas: Management Information Systems, Global McGraw Hill, 10th Edition, 2011, ISBN: 978-0072823110

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			RUBRIC for SEE		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II							
Course Code	:	22MAT2D12T	**STATISTICAL AND OPTIMIZATION METHODS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. PRAKASH R			

UNIT - I **9 Hrs**

Random Vectors:
Probability models of N random variables, Vector notation, Marginal probability functions, Independence of random variables and random vectors, Functions of random vectors, Expected value vector and Correlation matrix, Gaussian random vectors, Expected values of sums, Probability density function of the sum of two random variables, Moment Generating Functions (MGF), MGF of the sum of independent random variables, Characteristic function and Probability generating function.

UNIT - II **8 Hrs**

Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Variance of a point estimator, Methods of point estimation - Method of moments and Method of maximum likelihood, Bayesian estimation of parameters.

UNIT - III **9 Hrs**

Inferential Statistics: Principles of Statistical Inference, Formulation of the problems with examples. Test of hypothesis - Null and alternative hypothesis, Procedure for statistical testing, Type I and Type II errors: level of significance, Rejection regions and power, Standard Normal null distribution (Z-test), Z-tests for means and proportions, Duality: two-sided tests and two-sided confidence intervals, P-value, Inference about variances, Special tests of significance for large and small samples (F, Chi – square, Z, t – test).

UNIT - IV **8 Hrs**

Fuzzy Optimization:
Basic concepts of fuzzy sets - Operations on fuzzy sets, Fuzzy relation equations, Fuzzy logic control, Fuzzification, Defuzzificatiuon, Knowledge base, Decision making logic, Membership functions, Rule base.
Artificial Neural Networks: Introduction - Neuron model, Multilayer perceptions - Back propagation algorithm and its variants, Loss functions in artificial neural networks, Stochastic gradient descent method.

UNIT - V **8 Hrs**

Machine Learning Algorithms:
Data mining, Hierarchy Clustering, k-Means Clustering, Distance Metric, Data mining for Big data, Characteristics of Big data, Statistical nature of Big data, Support Vector Machines, Statistical Learning Theory, Linear Support Vector Machine, Kernel functions and Nonlinear Support Vector Machines.

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

CO1	:	Illustrate the fundamental concepts of statistics, random variables, estimation, inferential statistics, fuzzy optimization and machine learning algorithms.
CO2	:	Derive the solution by applying the acquired knowledge of random variables, estimation, inferential statistics, fuzzy optimization and machine learning algorithms to the problems of engineering applications.
CO3	:	Evaluate the solution of the problems using appropriate statistical and probability techniques to the real world problems arising in many practical situations.
CO4	:	Compile the overall knowledge of statistics, probability distributions and estimation, tests of hypothesis and optimization gained to engage in life – long learning.

Reference Books:

1. Roy D. Yates, David J. Goodman, “Probability and Stochastic Processes”, 3rd Edition, An Indian Adaptation, Wiley, 2021, ISBN: 9789354243455.

2. Douglas C. Montgomery and George C. Runger, “Applied Statistics and Probability for Engineers”, 7th Edition, John Wiley & Sons, 2019, ISBN: 9781119570615.

3. Trevor Hastie Robert Tibshirani Jerome Friedman, “The Elements of Statistical Learning - Data Mining, Inference, and Prediction”, 2nd Edition, Springer, 2009 (Reprint 2017), ISBN-10: 0387848576, ISBN-13: 9780387848570.

4. Michael Baron, “Probability and Statistics for Computer Scientists”, 2nd Edition, CRC Press, 2014, ISBN- 13: 978-1-4822-1410-9.

5. Shai Shalev-Shwartz and Shai Ben-David “Understanding Machine Learning: From Theory to Algorithms”, 1st Edition, Cambridge University Press, 2014, ISBN: 978-1-107-05713-5.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	22ME2D13T	**INDUSTRY 4.0**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Gopalakrishna H D				

UNIT - I — **8 Hrs**

Fundamentals of Industry 4.0
Introduction, Industry 4.0, RAMI 4.0 (Reference Architecture Model Industry 4.0), Servitization, Product Service-System (PSS) Industry 4.0 across the Sectors Introduction, Transportation 4.0: Multimodal Transportation Systems, Rail 4.0, Digital Transformation of Railways, Logistics 4.0 (Implications), Fundamentals of Industry 4.0, Introduction, Industry 4.0, RAMI 4.0 (Reference Architecture Model Industry 4.0), Servitization, Product Service-System (PSS)
Industry 4.0 across the Sectors
Introduction, Transportation 4.0: Multimodal Transportation Systems, Rail 4.0, Digital Transformation of Railways, Logistics 4.0 (Implications)

UNIT - II — **8 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 — **8 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 — **9 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 — **9 Hrs**

Augmented Reality: Definitions and application of AR, VR, MR, Limitations of AR, VR, Hardware devices and Software systems, Technical issues and challenges in AR, Industrial applications, IoT and the Need for Data Rationalization
Internet of Things (IoT), Internet of Things Vision, Internet of Things (IoT) Frameworks, Architecture of Internet of Things (IoT), Visualizing the Internet of Things (IoT), Essential Technologies of the Internet of Things (IoT), Key Technologies Involved in Internet of Things, Enablers of IoT, 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. Alasdair Gilchrist, Industry 4.0 The Industrial Internet Of Things, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2. Alp Ustundag, Emre Cevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018 ISBN 978-3-319-57869-9.
3.Ovidiu Vermesan and Peer Friess, Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4.Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	22MCS24L	**Simulation and Characterization of RF Devices**	CIE Marks	:	50
Credits L-T-P	:	1-0-1		SEE Marks	:	50
Hours	:	14L + 28P	*(Coding / Skill Laboratory)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Mahesh A			

Content **28 Hrs**

1. Design and Simulation of RF Passive circuits using AWR
2. Design and Simulation of RF Active circuits using AWR
3. Design and simulation of RF transceiver system using AWR 4. Design and Simulation of Dipole Antenna and Horn Antenna using HFSS 5. Design and Simulation of Multiband Microstrip Patch Antenna for Mobile Applications using HFSS 6. Design and Simulation of Phased Array Antenna for Beam steering Applications using HFSS 7. Measurement of Radiation Pattern in Lab Environment and in Anechoic Chamber 8. Measurement of S-parameters, VSWR, power measurements of Microwave Passive components using Vector Network Analyzer and Spectrum Analyzer 9. Measurement of S-parameters, VSWR, power measurements and noise figure of Microwave Active components using Vector Network Analyzer and Spectrum Analyzer 10. Design of a T/R module using AWR/HFSS

Course Outcomes:

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

CO1	:	Review the concepts of RF components , circuits and RF subsystems
CO2	:	Design and evaluate antenna performance according to practical requirements
CO3	:	Characterize the Antenna and RF system using measurement setups
CO4	:	Evaluate the performance of Antennas and Passive devices using Simulation tools

Scheme of Continuous Internal Evaluation (CIE- Laboratory) : Only LAB Course 30 + 10 + 10 = 50. The Laboratory session is held every week as per the timetable and the performance of the student is evaluated in every session. The average of marks over number of experiments conducted over the weeks is considered for 30 Marks i.e (Lab Report, Observation & Analysis). The students are encouraged to implement additional innovative experiments in the lab (10 marks). At the end of the semester a test is conducted for 10 Marks (Lab Test). This adds to 50 Marks.

Scheme of Semester End Examination (SEE- Laboratory) : Only LAB Course 40 + 10 =50. Students will be evaluated for Write-up, Experimental Setup, Experiment Conduction with Results, Analysis & Discussions for 40 Marks and Viva will be conducted for 10 Marks adding to 50 Marks.

Only LAB Courses with 50 Marks

RUBRIC FOR CIE			RUBRIC FOR SEE	
Sl.No	Content	Marks	Content	Marks
1	Write Up, Setup, Conduction Results, Analysis & Discussions	30	1. Write Up, Setup, Conduction 2. Results, Analysis & Discussions	40
2	Innovative Experiment/Concept Design & Implementation	10		
3	Laboratory Internal	10	Viva Voce	10
	Total Marks	50	Total Marks	50

SEMESTER: II						
Course Code	:	**22HSS25T**	**PROFESSIONAL SKILL DEVELOPMENT- I**	CIE Marks	:	50
Credits L-T-P	:	2-0-0		SEE Marks	:	50
Hours	:	28L	*Common Course to all M.Tech Programs*	SEE Durations	:	2 Hrs
Faculty Coordinator:			Dr. C.Bindu Ashwini			

UNIT - I	4 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	8 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	6 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	5 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	5 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 inter personal working skills.
CO4	:	Demonstrate verbal communication skills with appropriate body language.

Reference Books:

1. The 7 Habits of Highly Effective People, Stephen R Covey Free Press, 2004 Edition, ISBN: 0743272455
2. How to win friends and influence people, Dale Carnegie General Press, 1st Edition, 2016, 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	Test 1 is conducted after the completion of 9 hours of training programme (3 Classes). Question paper will have two parts. Part A will be Quiz for 10 Marks and Part B for 50 Marks Descriptive answers.
II	Test 2 is conducted after the completion of 18 hours of training programme (6 Classes). Question paper will have two parts. Part A will be Quiz for 10 Marks and Part B for 50 Marks Descriptive answers. Total test marks will be reduced to 30 Marks and Total Quiz marks will be 20 Marks. Final CIE would be 50 Marks.
	CIE marks 20 Quiz + 30 Test = 50 Marks
Semester End Examination: SEE is conducted for 50 Marks for a duration of 2 hours.	

SEMESTER: III						
Course Code	:	22MCS31T	**Error Control Coding for Wireless Communication**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*Professional Core - 6*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Usharani K R			

UNIT - I	**9 Hrs**
Introduction to algebra: Groups, Fields, binary field arithmetic, Construction of Galois Field GF (2m) and its properties, Computation using Galois filed GF (2m) arithmetic, Vectors and Matrices.	
UNIT - II	**9 Hrs**
"BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic, Implementation of error correction. Non-binary BCH codes: Primitive BCH codes over GF(q), Reed -Solomon codes, decoding of non-binary BCH and RS codes: The Berlekamp - Massey Algorithm"	
UNIT - III	**8 Hrs**
"Majority Logic decodable codes: One -step majority logic decoding, Class of One-step majority logic decodable codes. Convolution codes: Encoding of convolutional codes, Transfer Function of convolution codes, Structural properties, Distance properties, Viterbi search decoding algorithm – soft decision and hard decision based, ZJ Stack Sequential decoding algorithm, Probability of error in convolution decoding for hard and soft decision cases. Punctured and Tail biting Convolution codes."	
UNIT - IV	**8 Hrs**
"Concatenated Codes: Single level Concatenated Codes, Multilevel Concatenated Codes (Formulation only), Soft decision Multistage Decoding (Formulation only). Tur for an example PCBC and one PCCC, Performance Analysis Formulation and one example only. Low Density parity-Check Codes: Introduction, Tanner Graphs, Geometric Construction of LDPC Codes, Decoding of LDPC Codes – Majority Logic, Bit Flipping."	
UNIT - V	**8 Hrs**
Polar Codes: Primary Concepts and Practical Decoding Algorithms-successive cancellation (SC) list and fast SC	

Course Outcomes:

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

CO1	:	Explain the principles and theory of Linear Algebra, and apply the same for BCH Codes in Communication systems.
CO2	:	Perform a decoding procedure for Majority logic decodable and Convolution codes
CO3	:	Test and evaluate the Convolution Codes schemes for performance.
CO4	:	Construct and Decode Concatenated codes and polar codesto perform close to Shannon Limit in a data Transmission system.

Reference Books

1. Error control coding, Shu Lin and Daniel J. Costello. Jr, Pearson, 2nd edition, 2011, ISBN 978-81-317-3440-7
2. Introduction to Error control coding, Salvatore Gravano, Oxford university press, , ISBN:019923678X , 2007
3. Theory and practice of error control codes, Blahut. R. E, Addison Wesley, ISBN: 0201101025, 1984
4. Coding theory A first course, Cambridge university press, SAN ling, chaoping xing,ISBN: 0521821916, 2004
5. Polar codes are referred from IEEE transaction papers and Journal papers.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER : III						
Next Generation Wireless LANs						
Course Code	**:**	**22MCS3E1T**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**42L+28T**		**SEE Duration**	**:**	**3 Hrs**

Faculty Coordinator: Dr. P N Jayanthi

Unit – I	**8Hrs**

Physical layer

History of IEEE 802.11, Orthogonal frequency division multiplexing background, MIMO/SDM basics, 802.11n propagation model, Antenna correlation, Doppler model.

PHY interoperability with 11a/g legacy OFDM devices

11a packet structure review, Mixed format high throughput packet structure.40 MHz channel- subcarrier design, spectral mask, channel design, mixed format preamble, data encoding and performance improvement.

Robust performance

Receive diversity, Spatial expansion, Space-time block coding, Low density parity check codes encoding
process, Effective code rate, LDPC coding gain.

Unit – II	**8 Hrs**

Medium access control

Protocol layering, Management functions, Distributed channel access, Data/ACK frame exchange, Hidden node problem, Enhanced distributed channel access, Block acknowledgement, HT-immediate block acknowledgement.

Unit – III	**8 Hrs**

MAC throughput enhancements

Throughput without MAC changes, MAC throughput enhancements, Throughput with MAC efficiency enhancements and Aggregation.

Advanced channel access techniques

Point coordination function and its limitations, HCCA and its limitations, Reverse direction protocol frame exchange and recovery, PSMP recovery and resource allocation.

Unit – IV	9 Hrs

Interoperability and coexistence

Station and BSS capabilities, Controlling station behavior, Phased coexistence operation (PCO) basic operation, Protection with 802.11b stations present, Protection with 802.11g or 802.11a stations present, Protection for OBSS legacy stations, RIFS burst protection, Greenfield format protection, RTS/CTS protection and CTS-to-Self-protection.

MAC frame formats

General frame format, Format of individual frame types, Data frames and Management Frame fields.

Unit – V	**9 Hrs**

Transmit beamforming

Singular value decomposition, Transmit beamforming with SVD, Eigenvalue analysis, Unequal MCS, Receiver design, Channel sounding, Channel state information feedback , Improved performance with transmit beamforming, Degradations, MAC considerations, Sounding PPDUs, Implicit feedback beamforming, Explicit feedback beamforming, Comparison between implicit and explicit , Fast link adaptation.

Introduction to IEEE 802.11ac and ax Technologies.

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

CO1: Illustrate the fundamental concepts of IEEE 802.11a packet structure, propagation model, Doppler model, preamble format and robust performance.

CO2: Evaluate management functions, distributed channel access techniques and data/ack frame exchange Fragmentation for Duplicate detection.

CO3: Analyze MAC throughput performance and efficiency enhancements techniques and check the interoperability.

CO4: Develop and evaluate the transmit beam forming with SVD for different real world scenarios.

Reference Books	
1	Next Generation Wireless LANs: Throughput, Robustness, and Reliability in 802.11n , Eldad Perahia and Robert Stacey, 1st Edition, 2008, Cambridge University Press, ISBN:9781107016767
2.	Next-Generation Wireless Networks Meet Advanced Machine Learning Applications, Ioan-Sorin Comşa and Ramona Trestian ,1st edition, 2019,IGI Global Publisher, ISBN: 1522574581.
3	Digital Communications Paperback, John G. Proakis and Masoud Salehi, 5th edition, 2014, McGraw Hill Education, ISBN: 9789339204792
4	Transmit Beamforming in Modern Wireless Communications: From Theory to Practice in LTE and WiFi Hardcover, Joonsuk Kim , Pengfei Xia , Yang Tang , 1st edition, 2018, Wiley–Blackwell ISBN:978-1118939475.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: III

Course Code	:	22MCS3E2T	**Cyber Security**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L +28T	*Elective E (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Kiran V				

UNIT - I **9 Hrs**

"Security Attacks (Interruption, Interception, Modification and Fabrication), Security Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking, ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks "

UNIT - II **9 Hrs**

"Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication, Secure Hash Functions and HMAC. "

UNIT - III **8 Hrs**

"Public key cryptography principles, public key cryptography algorithms, digital signatures, digital Certificates, Certificate Authority and key management Kerberos, X.509 Directory Authentication Service. "

UNIT - IV **8 Hrs**

Email privacy: Pretty Good Privacy (PGP) and S/MIME.IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management. Basic concepts of SNMP, SNMPv1 Community facility and SNMPv3. Intruders, Viruses and related threats.

UNIT - V **8 Hrs**

Firewall Design principles, Trusted Systems. Intrusion Detection Systems.Getting Started with Blockchain: Blockchain versus distributed ledger technology versus distributed databases - Comparing the technologies with examples - Public versus private versus permissioned Blockchain - Comparing usage scenarios - Privacy in Blockchain -Getting Started with Blockchain: Blockchain versus distributed ledger technology versus distributed databases - Comparing the technologies with examples - Public versus private versus permissioned Blockchain - Comparing usage scenarios - Privacy in Blockchain. Security for VLSI and FPGA.

Course Outcomes:

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

CO1	:	Gain a complete knowledge on types of security attacks, services and mechanisms.
CO2	:	Understand the implementation of Internetwork security model and its standards and vulnerabilities
CO3	:	Demonstrate the Conventional Encryption Principles and the Public key Cryptography principles
CO4	:	Build a model of Firewall and test the security issues

Reference Books

1. Network Security Essentials (Applications and Standards), William Stallings, 6th edition, Pearson Education, ISBN: 9789352866601, 2018

2. Network Security - Private Communication in a Public World, CharlienKaufman, Radia Perlman and Mike Speciner, Pearson/PHI, ISBN: 9789332578210, 2016

3. Practical Aritifical Intelligence and Blockchain, Ganesh Prasad Kumble, First Edition, Packt Publishing Ltd, ISBN:1838822291, 2020

4. Cryptography and network Security, Third edition, Stallings, PHI/Pearson, ISBN: 9789332585225, 2017

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.

TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: III

Course Code	:	22MCS3E3T	**Modern Radar Systems**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*Elective E (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Nethravathi K A			

UNIT - I	**9 Hrs**
Introduction, Radar Basics, Radar Equation including its search and track forms, Displays, Receivers, Transmitters, Radar Antennas including Reflectors and Phased Array Antennas	
UNIT - II	**9 Hrs**
Radar Cross Section- Monostatic and Bistatic, Statistical Models for Noise and Target RCS, Constant False Alarm Rate Detectors, Target classification using AI	
UNIT - III	**8 Hrs**
General Characteristics of Clutter and Clutter Modelling, Clutter Reduction Techniques of Doppler and MTI.	
UNIT - IV	**8 Hrs**
Radar Measurements, Pulse compression, Radar Tracking, Radar Detection and Target Classification , Displaced-Phase-Center Antenna Space-time adaptive processing.	
UNIT - V	**8 Hrs**
An Overview of Radar Imaging :Introduction, General Imaging Considerations ,Resolution Relationships and Sampling Requirements, Data Collection ,Image Formation ,Image Phenomenology. Applications of Radar in Automotive, Military ,Law enforcement, Space, Remote sensing of environment, ,Aircraft navigation, Ship Navigation, Air Traffic Controller.	

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

CO1	:	Able to carry out research and development of the RADAR systems design.
CO2	:	To enable the students to demonstrate on Statistical Models for Noise and Target RCS.
CO3	:	To develop the knowledge in RADAR depending on the application and involvement of signal processing fundamentals.
CO4	:	To enable the students on matched filtering, detection and estimation, statistical approaches of signal processing through rigorous analysis of RADAR sub-systems.

Reference Books

1. Principles Of Modern Radar:Basic Principles by Mark A Richards, James A Scheer, William A Holm 30th June, 2010, Publisher, Institution of Engineering and Technology, 2010 ; ISBN, 1891121529, 9781891121524.
2. Introduction to Radar Systems-Merill I Skolnik, Third Edition,2001, MCGraw-Hill ISBN 13: 9780072909807
3. Radar Principles,Peyton Z Peebles,First Edition,2007,Wiley India, ISBN 13: 9788126515271
4. Radar Principles, Technology,Byron Edde, First Edition,2012,Pearson Education Limited, ISBN:139788131713839
5. Radar Principles,Peyton Z Peebles,First Edition,2007,Wiley India, ISBN 13: 9788126515271

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The sum of two quizzes will be the Final Quiz marks.
TESTS: Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. Final test marks will be reduced to 40 Marks.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 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.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			RUBRIC for SEE		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes – Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER III							
Course Code	:	22MCS32N	**INTERNSHIP**	CIE Marks	:	50
Credits L-T-P	:	0 - 0 - 6		SEE Marks	:	50
Hours/Week	:	12		SEE Durations	:	3 Hrs

Guidelines:

1. The duration of the internship shall be for a period of 6 weeks on full time basis after II semester final exams and before the commencement of III semester.
2. The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3. Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4. Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5. Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. 6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be softbound in Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

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

CO1: Apply Engineering and Management principles to solve the problems
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and lifelong learning

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor. The committee shall assess the presentation and the progress reports.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
I	Application of Engineering knowledge in industries, ability to comprehend the functioning of the Organization/ Departments.	40%
II	Importance of Resource Management, Environment and Sustainability. Demonstration and Presentation of Internship work with Report Submission	60%

Scheme for Semester End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER III							
Course Code	:	22MCS33P	**MINOR PROJECT**	CIE Marks	:	50
Credits L-T-P	:	0 - 0 - 6		SEE Marks	:	50
Hours/Week	:	12		SEE Durations	:	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 minor project would be performed in-house.
5. 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 shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor and Associate Professor/Assistant Professor.

Phase *	Activity	Weightage
I	Approval of the selected topic, formulation of Problem Statement and Objectives with Synopsis submission	20 %
II	Mid-term seminar to review the progress of the work with 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 Problem Statement and Objectives	10 %
• Design and simulation/ Algorithm development/ Experimental setup	25 %
• Conducting experiments/ Implementation / Testing	25 %
• Demonstration & Presentation	25 %
• Report writing	15 %

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%
• Methodology and Experimental Results & Discussion 20%
• Presentation / Demonstration of the Project 25%
• Report 20%
• Viva Voce 30%

SEMESTER IV							
Course Code	:	22MCS41P	**MAJOR PROJECT**	CIE Marks	:	100
Credits L-T-P	:	0 - 0 - 18		SEE Marks	:	100
Hours/Week	:	36		SEE Durations	:	3 Hrs

Guidelines:
1. Major Project is to be carried out for a duration of 18 weeks
2. Students must adhere to the Project Presentation Schedule, report to their guide on a weekly basis and get their Project diary signed by their guide 4. Students must execute the Major Project individually and not in teams.
5. It is mandatory for the students to present/publish their project work in National/International Conferences or Journals
6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be soft bound and in Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs

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 project and resource managements skills, professional ethics and societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination
Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor.

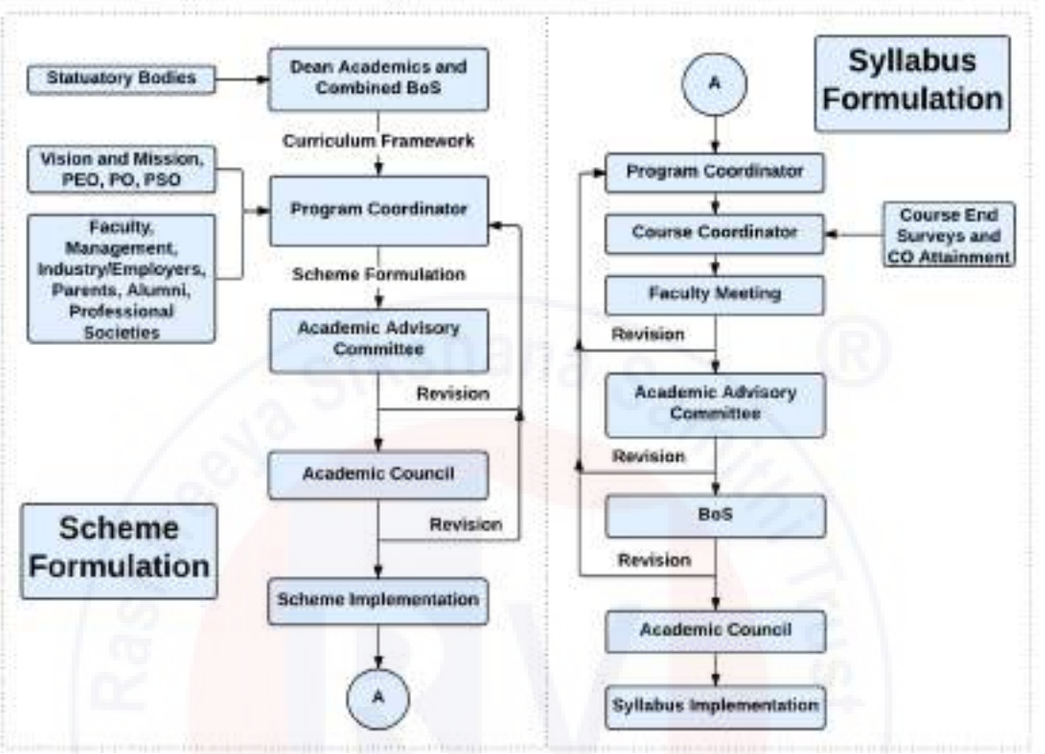
Phase *	Activity	Weightage
I	Selection of Project Title, Formulation of Problem Statement and Objectives	20 %
II	Design, Implementation and Testing	40 %
II	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40 %

* Phase wise rubrics to be prepared by the respective departments

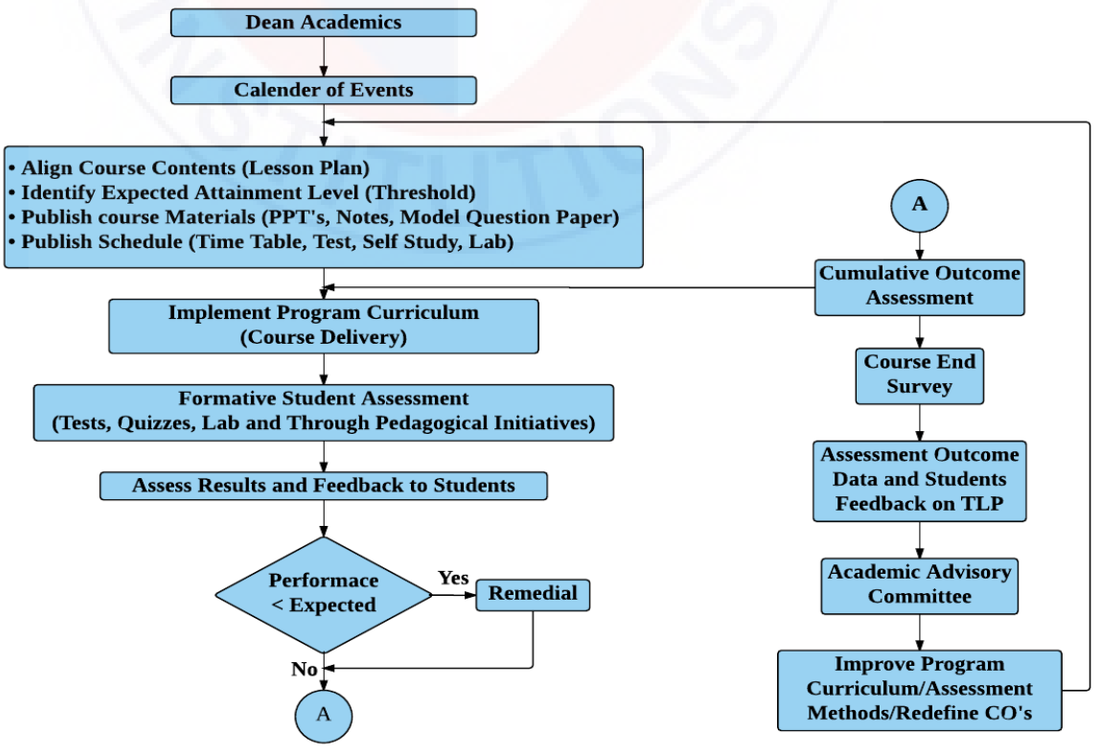
Scheme for Semester End Evaluation (SEE):
Major Project SEE evaluation shall be conducted in two stages. This is initiated after fulfilment of submission of Project Report and CIE marks.
Stage-1 Report Evaluation: Evaluation of Project Report shall be done by the Guide and an External examiner.
Stage-2 Project Viva-voce: Major Project Viva-voce examination is conducted after receipt of evaluation reports from Guide and External examiner.

SEE procedure is as follows:			
Report Evaluation	Internal Examiner: 100 Marks	**= 200**	
	External Examiner: 100 Marks	200 / 2 = **100**	**A**
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator	**= 100**	**B**
	Total Marks = (A + B) / 2 =	**100**	

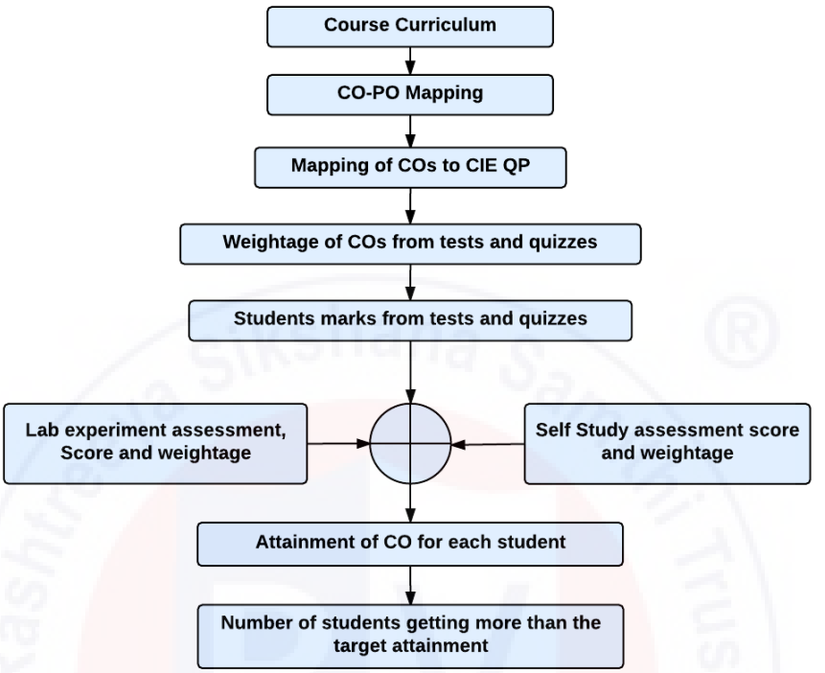
Curriculum Design Process



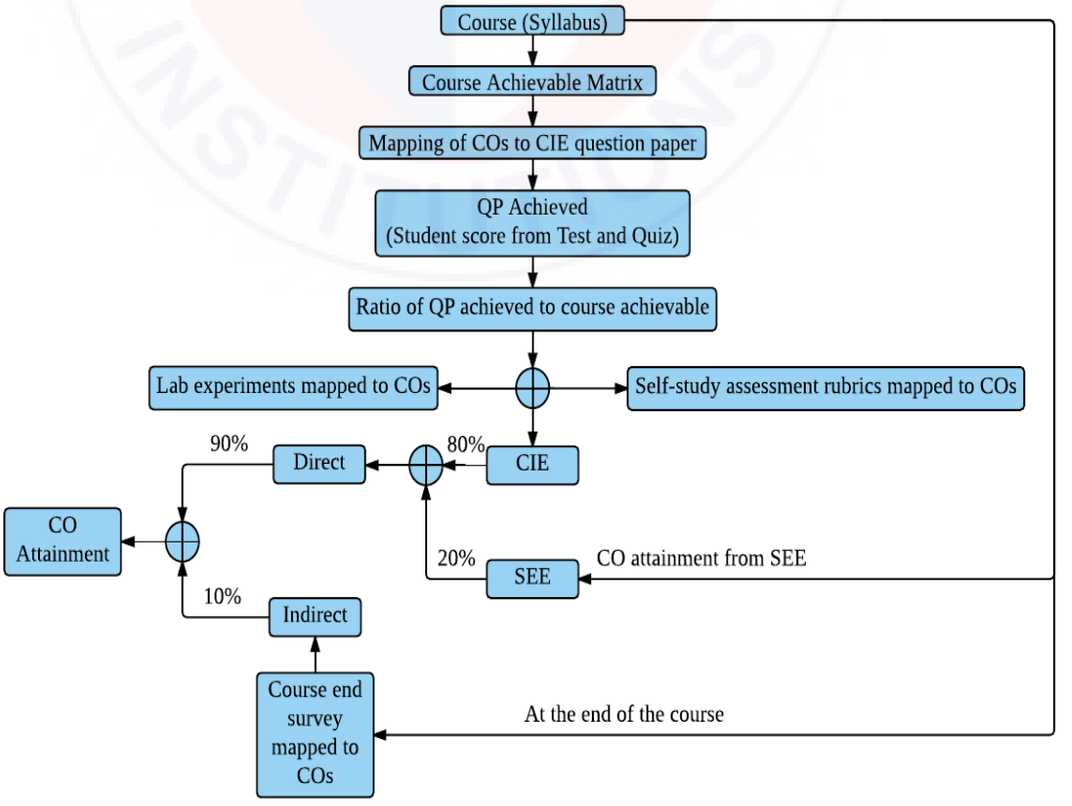
Academic Planning And Implementation



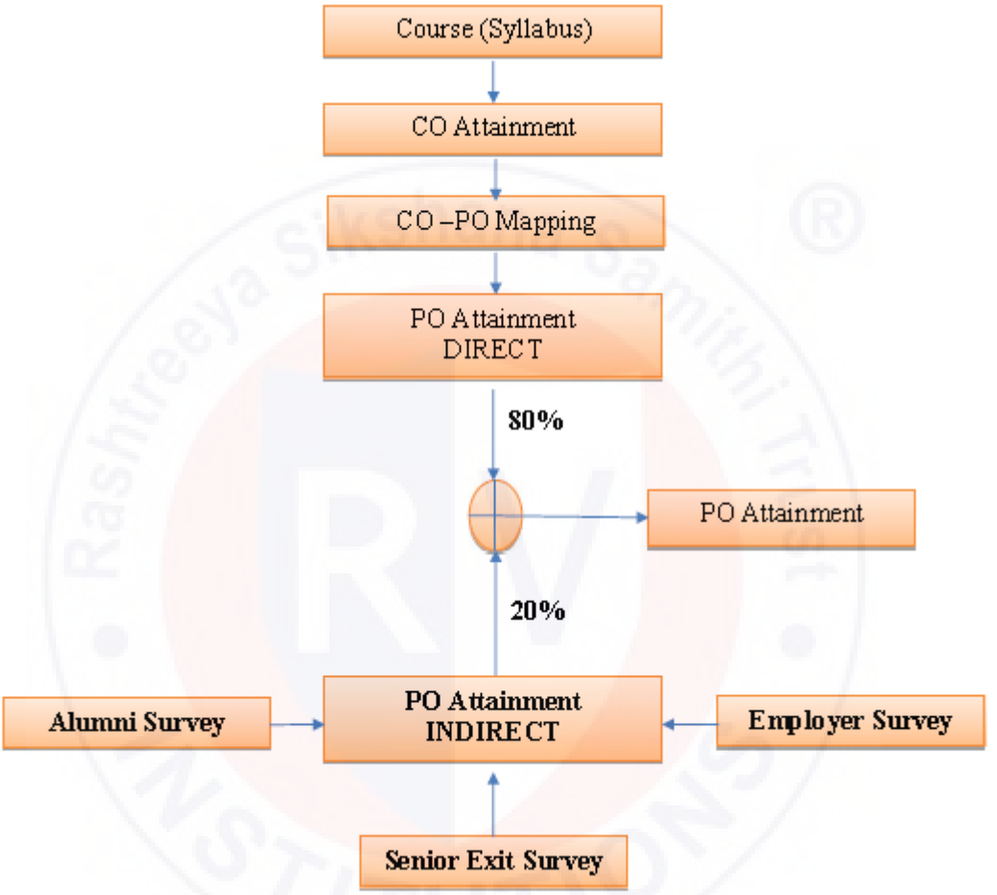
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



Innovative Clubs of RVCE

1	**Ashwa Racing**	Ashwa Mobility Foundation (AMF) is a student R&D platform that designs and fabricates Formula theme race cars and future mobility solutions to tackle urban transportation problems.
2	**Astra Robites**	Team involved in the design, fabrication and building application specific robots.
3	**Coding Club**	To facilitate students the skills, confidence, and opportunity to change their world using coding and help them become successful in GSoC, ACM-ICPC, and other recognized coding competitions.
4	**Entrepreneurship Development Cell**	E-Cell is a student run body that aims to promote entrepreneurship by conducting workshops, speaker sessions and discussions on business and its aspects. We possess a mentor board to help startups grow.
5	**Frequency Club**	Team aims at contributing in both software and hardware domains mainly focusing on Artificial Intelligence, Machine Learning and it's advances.
6	**Garuda**	Design and development of supermileage urban concept electric car. Indigenous development of E-mobility products.
7	**Jatayu**	Build a low cost Unmanned Aerial Vehicle capable of Autonomous Navigation, Obstacle Avoidance, Object Detection, Localization, Classification and Air Drop of a package of optimum weight.
8	**Solar Car**	Build a roadworthy solar electric vehicle in order to build a green and sustainable environment.
9	**Team Antariksh**	Team Antariksh is a Space Technology Student Club whose goal is to understand, disseminate and apply the engineering skills for innovation in the field of Space technology. designing Nano-Satellite payload for ISRO PS4 Orbital platform, RVSAT-1 along with developing experimental rockets of various altitude.
10	**Team Chimera**	Building a Formula Electric Car through Research and Development in E-Mobility. Electrifying Formula Racing.
11	**Helios Racing**	Team involved in design, manufacturing and testing of All-Terrain Vehicles and other supportive tasks for the functioning of the team. Participating in BAJA competitions organized by SAE in India and the USA.
12	**Team Hydra**	Developing autonomous underwater vehicles and use it for various real world applications such as water purification, solid waste detection and disposal etc.
13	**Team Krushi**	Develop low cost equipments, which help farmers in cultivating and harvesting the crops. Use new technology applications to reduce the labour time hand cost for farmers. Aims at developing implants for Tractors.
14	**Team vyoma**	Design, fabrication and testing of radio controlled aircrafts and research on various types of unmanned aerial vehicles.
15	**Team Dhruva**	Organizing activities like quizzes based on astronomy.Stargazing and telescope handling sessions.Construction of a standard observatory. working on small projects with organizations like ICTS, IIA, ARIES etc.
16	**Ham club**	To popularize Amateur Radio as a hobby among students, alongside exploring technical innovations in the communications domain. Intended to provide human capital for service to the nation at times of natural calamities.

NCC

NSS

"Not me but you"
" Education through Community Service & Community Service through education"

Cultural Activity Teams

1. **AALAP (Music club)**
2. **DEBSOC (Debating society)**
3. **CARV (Dramatics club)**
4. **FOOTPRINTS (Dance club)**
5. **QUIZCORP (Quizzing society)**
6. **ROTARACT (Social welfare club)**
7. **RAAG (Youth club)**
8. **EVOKE (Fashion team)**
9. **f/6.3 (Photography club)**
10. **CARV ACCESS (Film-making club)**

VISION

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

MISSION

- To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
- To create a conducive environment for interdisciplinary research and innovation.
- To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
- To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
- 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, Innovation

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