ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾ ವಿದ್ಯಾಲಯ

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾಸಂಸ್ಥೆ)

ಬೆಂಗಳೂರು ೫೬೦ ೦೧೯

BMS COLLEGE OF ENGINEERING

(Autonomous College under VTU)

BANGALORE - 560019

ELECTRONICS & COMMUNICATION ENGINEERING

SCHEME & SYLLABUS

III to VIII SEMESTER

2019-20 Batch Onwards

ECE

B M S C E

ಬಿ. ಎಂ. ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)

ಬಸವನಗುಡಿ ರಸ್ತೆ, ಬೆಂಗಳೂರು ೫೬೦೦೧೯

B.M.S. College of Engineering, Bengaluru – 19

Autonomous College under VTU

Department of Electronics & Communication Engineering

Scheme and Syllabus for III-VIII Semester

Batch admitted 2019

INSTITUTE VISION

Promoting Prosperity of mankind by augmenting Human Resource Capital through Quality Technical Education & Training.

INSTITUTE MISSION

Accomplish Excellence in the field of Technical Education through Education, Research and Service needs of society.

DEPARTMENT VISION

To emerge as a centre of academic excellence in electronics, communication and related domains through knowledge acquisition, knowledge dissemination and knowledge generation meeting global needs and standards.

DEPARTMENT MISSION

Imparting quality education through state-of-the-art curriculum, conducive learning environment and research with scope for continuous improvement leading to overall professional success.

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1 Graduates will Professionally Progress in Electronics, Communication and related areas with an inclination towards Continuous Learning

PEO 2 Graduates will work in Diversified Teams of Multidisciplinary Environment

PEO 3 Graduates will exhibit good Inter-personal skills, adapt themselves for changes in Contemporary Technology

PROGRAM SPECIFIC OUTCOMES

The students will be able to:

PSO1 Analyse and design electronic systems for signal processing and communication applications.

PSO2 Demonstrate the Conceptual domain Knowledge with respect to Architecture, Design, Analysis and Engineering deployment in Data communication and Computer networking.

PSO3 Identify and apply domain specific tools for design, analysis, synthesis and validation of VLSI and Communication systems.

PROGRAM OUTCOMES

Program Outcomes (POs), are attributes acquired by the student at the time of graduation. The POs given below ensure that the POs are aligned to the Graduate Attributes (GAs) specified by National Board of Accreditation (NBA). These attributes are measured at the time of Graduation, and hence computed every year for the outgoing Batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum.

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Distribution of Credits among various Curricular Components

Sem	Humanities and Social Science Course (HS)	Basic Science Course (BS)	Engineering Science course (ES)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project Work (PW)	Technical Seminar (SR)	Internship Seminar (ISR)	Non Credit Mandatory Course (NC)	Total Credits
I		9	11							NC 1	**20**
II		9	11							NC 2	**20**
III	1	4		19			1			NC 3	**25**
IV	2	4	4	15						NC 4	**25**
V	2			15	6		2			NC 5	**25**
VI	2			12	6	3		2		NC 6	**25**
VII	3	2		6	3	3	2			NC 7	**19**
VIII	2					3	9		2	NC 8	**16**
Course Total	**12**	**28**	**26**	**67**	**15**	**9**	**14**	**2**	**2**		**175**

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SCHEME

SEMESTER: III

Sl. No.	Code	Course Title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19MA3BSEM3	Engineering Mathematics – III	BS	3	1	0	4	5	50	50	100
2	19ES3CCECA	Electrical Circuit Analysis	PC	3	1	0	4	5	50	50	100
3	19ES3CCAEC	Analog Electronic Circuits	PC	3	0	1	4	5	50	50	100
4	19ES3CCDEC	Digital Electronic Circuits	PC	3	0	1	4	5	50	50	100
5	19ES3GCFTH	Field Theory	PC	3	1	0	4	5	50	50	100
6	19EC3DCMSA	Modern Sensors and its Applications	PC	3	0	0	3	3	50	50	100
7	19EC3PWMP1	Mini Project I	PW	0	0	1	1	2	50	50	100
8	19IC3HSCPH	Constitution of India, Professional Ethics and Human Rights	HS	1	0	0	1	1	50	50	100
9	19EC3NCPYA	Physical activity	NC	-	-	-	-	2	-	-	P/NP
			Total	**19**	**3**	**3**	**25**	**33**	**400**	**400**	**800**

SEMESTER: IV

Sl. No.	Code	Course Title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19MA4BSEM4	Engineering Mathematics –IV	BS	3	1	0	4	5	50	50	100
2	19ES4ESCST	Control Systems	ES	3	1	0	4	5	50	50	100
3	19ES4CCLIC	Linear Integrated Circuits	PC	3	0	1	4	5	50	50	100
4	19ES4CCMCS	Microcontrollers	PC	3	0	1	4	5	50	50	100
5	19ES4CCSAS	Signals and Systems	PC	3	1	0	4	5	50	50	100
6	19EC4PCHDL	HDL Programming	PC	2	1	0	3	4	50	50	100
7	19HS4ICEVS	Environmental studies	HS	2	0	0	2	2	50	50	100
8	19EC4NCCAS	Media Communication / Sanskrit for Science	NC	-	-	-	-	2	-	-	P/NP
			Total	**19**	**4**	**2**	**25**	**33**	**350**	**350**	**700**

SEMESTER: V

Sl. No.	Code	Course Title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19EC5PCCT1	Communication Theory I	PC	3	0	1	4	5	50	50	100
2	19EC5PCFOV	Fundamentals of VLSI	PC	3	0	0	3	3	50	50	100
3	19EC5PCANT	Antenna Theory	PC	3	1	0	4	5	50	50	100
4	19ES5CCDSP	Digital Signal Processing	CC	3	0	1	4	5	50	50	100
5	19EC5PE1XX	Program Elective – I	PE	3	0	0	3	3	50	50	100
6	19EC5PE2XX	Program Elective – II	PE	3	0	0	3	3	50	50	100
7	19EC5PWMP2	Mini Project – II	PW	0	0	2	2	4	50	50	100
8	19ES5HSIFE	Innovation for Entrepreneurship	HS	2	0	0	2	2	50	50	100
9	19EC5NCCMS	Community service	NC	-	-	-	-	2	-	-	P/NP
			Total	**20**	**1**	**4**	**25**	**32**	**400**	**400**	**800**

Program Elective – I:

19EC5PE1CA	Computer Architecture
19EC5PE1AD	Advanced Digital Logic Design
19EC5PE1PS	Probability & Statistics
19EC5PE1OP	Object Oriented Programming using C++

Program Elective – II:

19EC5PE2SC	Satellite Communication
19EC5PE2IP	Image Processing
19EC5PE2RB	Robotics
19EC5PE2OS	Operating System

SEMESTER: VI

Sl. No.	Code	Course Title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19EC6PCCCN	Computer Communication Networks	PC	3	0	1	4	5	50	50	100
2	19EC6PCMSD	Mixed Signal Design	PC	3	0	1	4	5	50	50	100
3	19EC6PCCT2	Communication Theory II	PC	3	0	1	4	5	50	50	100
4	19EC6PE3XX	Program Elective – III	PE	3	0	0	3	3	50	50	100
5	19EC6CE1XX	Cluster Elective – I	CE	3	0	0	3	3	50	50	100
6	19EC6OE1XX	Open Elective – I	OE	3	0	0	3	3	50	50	100
7	19EC6SRTSR	Technical Seminar†	SR	0	0	2	2	4	50	50	100
8	19GC6HSEEC	Engineering Economics	HS	2	0	0	2	2	50	50	100
9	19EC6NCPDC	Professional Development and Communication	NC	-	-	-	-	2	-	-	P/NP
			Total	**20**	**0**	**5**	**25**	**34**	**400**	**400**	**800**

†Technical Seminar on Safety & Standards / Sustainability & Environment / Engineering & Technology for Society

Program Elective – III:

19EC6PE3AE	Automotive Embedded System
19EC6PE3SV	System Verilog & Verification
19EC6PE3DS	Data Structures & Algorithms
19EC6PE3IT	Internet of Things

Cluster Elective – I:

19EC6CE1ML	Machine Learning
19EC6CE1AM	Advanced Microcontroller and Applications
19EC6CE1CV	Computer Vision
19EC6CE1PD	Physical Design

Open Elective – I:

19EC6OE1EM	Electronic Engineering Materials

SEMESTER: VII

Sl. No.	Code	Course Title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19ES7BSBFE	Biology for Engineers	BS	2	0	0	2	2	50	50	100
2	19EC7PCESD	Embedded System Design	PC	3	0	1	4	4	50	50	100
3	19EC7PCRFM	RF & Microwave Engineering	PC	2	0	0	2	2	50	50	100
4	19EC7CE2XX	Cluster Elective – II	CE	3	0	0	3	3	50	50	100
5	19EC7OE2XX	Open Elective – II	OE	3	0	0	3	3	50	50	100
6	19ES7HSPMF	Project Management & Finance	HS	3	0	0	3	3	50	50	100
7	19EC7PWMP3	Mini Project – III	PW	0	0	2	2	4	50	50	100
8	19EC7NCMCC	Any MOOC Course with Certification	NC	-	-	-	-	2	-	-	P/NP
			Total	**16**	**0**	**3**	**19**	**23**	**350**	**350**	**700**

Cluster Elective – II:

19EC7CE2WC	Wireless Communication
19EC7CE2NC	Network Security & Cryptography
19EC7CE2SC	System On Chip
19EC7CE2EP	Electronics Packaging
19EC7CE2LV	Low Power VLSI
19EC7CE2DL	Deep Learning

Open Elective – II:

19EC7OE2MC	Fundamentals of Mobile Communications

SEMESTER: VIII

Sl. No.	Code	Course Title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19ES8HSIPL	Intellectual Property Rights and Cyber Law	HS	2	0	0	2	2	50	50	100
2	19EC8OE3XX	Open Elective – III	OE	3	0	0	3	3	50	50	100
3	19EC8PWMPW	Major Project Work	PW	0	0	9	9	18	50	50	100
4	19EC8SRISR	Seminar on Internship	SR	0	0	2	2	4	50	50	100
5	19EC8NCMEP	MOOC Course on Engineering Practices	NC	-	-	-	-	2	-	-	P/NP
			Total	**5**	**0**	**11**	**16**	**29**	**200**	**200**	**400**

Open Elective – III:

19EC8OE3ME	Microelectromechanical Systems
19EC8OE3AE	Automotive Electronics

III Semester Syllabus

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Course Title	**ENGINEERING MATHEMATICS – III (Common to AS/CV/EE/EC/EI/ML/ET)**				
Course Code	**19MA3BSEM3**	**Credits**	**4**	**L – T – P**	**3:1:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply Numerical techniques to solve problems arising in engineering	1	–
CO2	Demonstrate an understanding of Fourier Series, Fourier Transforms and z-Transforms.	1	–
CO3	Apply the concepts of calculus to functional.	1	–

UNIT – I **09 Hrs (7L + 2T)**

MATRICES

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of a system of linear equations and solution. Solution of a system of non-homogenous equations: Gauss elimination method, Gauss-Seidel method, LU decomposition method, eigenvalues and eigenvectors of matrices, reduction of a matrix to diagonal form.

UNIT – II **09 Hrs (7L + 2T)**

FOURIER SERIES

Introduction: Dirichlet's conditions, Fourier series of periodic functions of period 2l, Fourier series of functions having points of discontinuity. Applications: Fourier series of typical waveforms like saw toothed waveform, triangular waveform, square waveform, half-wave rectifier, full wave rectifier and modified saw tooth waveform, exponential Fourier series, practical harmonic analysis.

UNIT – III **09 Hrs (6L + 3T)**

FOURIER TRANSFORMS

Infinite Fourier transform: Fourier Sine and Cosine transforms, properties, Inverse transforms. Convolution theorem, Parseval's identities.

UNIT – IV **10 Hrs (8L + 2T)**

NUMERICAL METHODS

Solution of algebraic and transcendental equations: Newton-Raphson method. Finite Differences and interpolation: Forward differences, backward differences. Newton- Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Simpson's 1/3 rule, Simpson's 3/8th rule, Weddle's rule. Numerical solution of ordinary differential equations: modified Euler's method, Runge-Kutta method of fourth order.

UNIT – V **11 Hrs (8L + 3T)**

CALCULUS OF VARIATIONS Variation of a functional, Euler's equation, variational problems. Applications: Hanging cable problem, Brachistochrone problem.

z-TRANSFORMS Definition, Properties, Transforms of standard functions, Inverse transforms. Solution of difference equations using z-transforms.

Text Books:

1. "Higher Engineering Mathematics", B. S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. "Advanced Engineering Mathematics", 4th edition, 2011, Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

Reference Books:

1. "Higher Engineering Mathematics", B. V. Ramana, 2007, Tata McGraw Hill.
2. "Advanced Engineering Mathematics", Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley- India.

E books and online course materials:

1. https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/lecture-notes/
2. https://www.pdfdrive.com/calculus-of-variations-e34313748.html

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111103021/22 (Fourier series and Transforms, Heat and Wave Equations)
2. https://nptel.ac.in/courses/122104018/2 (Numerical Methods)
3. https://nptel.ac.in/courses/111104025/ (Calculus of variation)

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Course Title	**ELECTRICAL CIRCUIT ANALYSIS**				
Course Code	**19ES3CCECA**	**Credits**	**4**	**L – T – P**	**3:1:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the basic circuital laws and network theorems to linear circuits	1	1
CO2	Interpret linear circuits using Graph Theory	1	1
CO3	Analyze two port networks and its parameters	2	1
CO4	Analyze a linear circuit in time and frequency domain	2	1
CO5	Simulate a linear circuit using appropriate tools	5	1

UNIT – I **10 Hrs**

Basic Concepts: Practical sources, Source Transformations, Network reduction using Star-Delta transformation, Loop and nodal analysis with linearly dependent and independent sources for DC and AC circuits, coupled circuit, Analysis of networks using concepts of super node, Super mesh.

UNIT – II **10 Hrs**

Network Topology: Graph of a network, Concept of tree and Co-tree, Incidence matrix, tie-set & cut-set schedules, Formulation of equilibrium equations, Principle of duality.

Resonant Circuits: Series and parallel resonance, frequency response of series and parallel circuits, Q factor, Bandwidth.

UNIT – III **10 Hrs**

Network Theorems: Superposition, Reciprocity, Millman's, Thevenin's and Norton's theorems, Maximum power transfer theorem.

UNIT – IV **10 Hrs**

Transient Behavior and Initial Conditions: Behavior of circuit elements under switching condition and their representation, Evaluation of Initial and Final conditions in RL, RC and RLC circuits.

Laplace Transformation & Applications: Review of Laplace transforms, Waveform Synthesis, Initial and Final value theorems, Step, Ramp and Impulse responses, Convolution theorem, solution of simple RL, RC, RLC networks for AC and DC excitations using Laplace transforms.

UNIT – V **10 Hrs**

Analysis of Two Port Network and its Parameters: Definition of Z, Y, T, h parameters, modeling, relationship between parameters sets.

Choice: Unit-I and Unit-IV

Text Books:

1. "Network Analysis", M.E.Van Valkenburg, PHI/ Pearson Education, 3rd Edition. Reprint 2002.
2. "Networks and systems ", Roy Choudhury, 2nd edition, 2006 reprint, New Age International Publications.
3. "Theory and Problems of Electric Circuits", Schaum's Series, 2nd Edition McGraw Hill.

Reference Books:

1. "Engineering Circuit Analysis", Hayt, Kemmerly and Durbin, TMH 6th 2002.
2. "Network analysis and Synthesis", Franklin F. Kuo, Wiley Edition.
3. "Analysis of Linear Systems", David K. Cheng, Narosa Publishing House, 11th reprint, 2002.
4. "Circuits", Bruce Carlson, Thomson learning, 2000. Reprint 2002.
5. "Network analysis and Synthesis", Anand Kumar, PHI Learning, 2019.

MOOCs:

1. `http://elearning.vtu.ac.in/06ES34.html`
2. `https://www.coursera.org/course/circuits`

B.M.S. College of Engineering, Bengaluru – 19

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Course Title	ANALOG ELECTRONIC CIRCUITS				
Course Code	19ES3CCAEC	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Define, understand and explain concepts related to diodes and transistors (BJTs and MOSFETs)	–	1
CO2	Apply the knowledge of network theorems and device models to solve given analog electronic circuits	1	1
CO3	Analyze a given analog electronic circuits to compute required parameters	2	1
CO4	Design analog electronic circuits for a given specification	3	1
CO5	Conduct experiments to demonstrate the knowledge of design and analysis using circuit simulators/hardware	5, 9	1

UNIT – I **8 Hrs**

Diode Applications: Introduction, load line analysis, Series diode configurations, Parallel and series–parallel configurations, clippers, Clampers.

Bipolar Junction Transistor (BJTs): DC biasing– Introduction, Operating point, Voltage Divider Bias configuration

BJT AC Analysis: Introduction, Application in the AC Domain, BJT Transistor Modeling Transistor model, Voltage Divider Bias

UNIT – II **8 Hrs**

BJT Frequency Response: Introduction, Logarithms, Decibels, Low frequency Response-BJT Amplifier, Miller effect Capacitance, High Frequency response – BJT Amplifier

Feedback concepts: Feedback connection types – Voltage series, Voltage-shunt, Current Series and Current Shunt Feedback.

Practical feedback Circuits: Voltage series, Current series feedback and voltage Shunt feedback.

UNIT – III **8 Hrs**

Power Amplifiers: Introduction – Definitions and Amplifier Types, Amplifier Efficiency Series-Fed Class A Amplifier: DC Bias Operation, AC operation, Power Consideration, Efficiency.

Transformer coupled Class A Amplifier: Operation of Amplifier Stage: DC load line, Quiescent operating point, AC load line, Signal Swing and Output AC power.

Class B operation: Class B Amplifier Circuits, Transformer coupled Push-Pull Circuits, Complementary Symmetry Circuits and Amplifier Distortion.

UNIT – IV **8 Hrs**

MOSFETs: Introduction, Device structure and physical operation – Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small V_{DS}, Operation as V_{DS} is increased, Derivation of the $I_D - V_{DS}$ relationship, The p-channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the sub-threshold region.

Current voltage Characteristics: Circuit symbol, $I_D - V_{DS}$ characteristics, characteristics of the p-channel MOSFET

MOSFET Circuits at DC: The MOSFET as an amplifier and as a switch: Large-signal operation, Graphical derivation of the transfer characteristic, operation as a switch, operation as a linear amplifier.

Biasing in MOS amplifier circuits: Biasing by fixing V_{GS}, Biasing by fixing V_G and connecting a resistor in the source, Biasing using a drain to gate feedback resistor, biasing using a current source.

UNIT – V **8 Hrs**

Small signal operation and models of MOSFETs: The DC bias point, the signal current in the drain terminal, the voltage gain, separating dc analysis and the signal analysis, small-signal equivalent circuit models, the transconductance g_m, the T equivalent circuit model.

Single stage MOS amplifiers: The basic structure, characterizing amplifiers, The CS amplifier, The CS amplifier with a source resistance, Common gate (CG) Amplifier, The common Drain or source follower Amplifier.

IC Biasing: Current sources, current mirror and current steering circuits: The basic MOSFET current source, MOS current steering circuits

Current mirror circuit with improved performance: The Wilson MOS mirror.

Choice: Unit-I and Unit-V

Text Books:

1. "Electronic Devices and Circuit Theory", Robert L. Boylestad and Louis Nashelsky, 10th Edition, Pearson Education.
2. "Microelectronic Circuits: Theory and Applications", Adel S. Sedra and Kenneth C. Smith, 5th Edition, Oxford International Student Edition.

Reference Books:

1. "Electronic Devices and Circuits", Millman and Halkias, TMH.
2. "Electronic Devices and Circuits", David A. Bell, 4th Edition, PHI.

E Books:

1. `www.pyroelectro.com/edu/analog`
2. `http://freevideolectures.com/course/3020/circuits-for-Analog-System-Design`

MOOCs:

1. `https://www.mooc-list.com/course/electronic-systems-and-digital-electronics-uninettuno?static=true`
2. `http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-spring-2009/`
3. Introductory Analog Electronics Laboratory (Spring 2007) by MIT open course ware

LABORATORY EXPERIMENT LIST

Sl. No.	Title of the Experiments
	Conduction using Hardware
1.	To design and configure BJT as a switch
2.	Design of Bridge rectifier with Capacitor filter
3.	Zener diode characteristics and Zener as regulator
4.	Diode clipping circuits – Single/Double ended
5.	Diode clamping Circuits – Positive clamping/negative clamping
6.	Performance analysis of RC coupled amplifier using BJT
7.	Design and analysis of BJT as RC phase shift oscillator
8.	Design and analysis of Crystal Oscillators

Sl. No.	Title of the Experiments
Conduction using Hardware	
9.	Performance analysis of class – B Power Amplifier
10.	To study voltage series feedback amplifier using BJT
Conduction using Simulation Tools	
11.	To obtain the characteristics of MOSFET
12.	To design a CS amplifier circuit using MOSFET

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Course Title	**DIGITAL ELECTRONIC CIRCUITS**				
Course Code	**19ES3CCDEC**	**Credits**	**4**	**L – T – P**	**3:0:1**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Understand the fundamental logic functions and Basic Building blocks of Digital Logic design	1	3
CO2	Analyse and Realise logic functions by choosing the suitable logic blocks	2	3
CO3	Optimize the logic circuit with cost effective solution	2	3
CO4	Design a complete digital circuit for given problem statement by applying the digital circuit concepts	3	3
CO5	Conduct experiments using digital ICs to demonstrate a given application/problem statement	4, 9, 10, 12	3

UNIT – I **8 Hrs**

Introduction: Review of Boolean algebra, logic gates.

Simplification of Boolean functions: Three Variable, Four Variable and Five Variable K-Maps, The Tabulation Method, Design with Basic gates, NAND gates and NOR gates.

UNIT – II **8 Hrs**

Combinational Logic Circuits: Introduction, Parallel Adders (Carry Look Ahead Adder and Ripple carry adder), Decimal Adder, Code conversion, Magnitude Comparator, Decoders, Multiplexers, Read Only memories (ROM), Programmable Logic Arrays (PLAs).

UNIT – III **8 Hrs**

Sequential Logic Circuits: The Basic Flip-flop circuit, Clocked Flip-flops, Triggering of Flip-flops: Master Slave Flip-Flops, Edge Triggered Flip-Flops, Characteristic Equations, Conversion of flip-flops, Shift Registers, Ripple Counters, Synchronous Counters.

UNIT – IV **8 Hrs**

Sequential systems: Analysis of Clocked Sequential circuits, State Reduction and Assignment, Design Procedure, Design with State Equations, Sequence detector.

UNIT – V **8 Hrs**

Logic Families: Characteristic of Digital ICs, Transistor - Transistor Logic, Complementary MOS (CMOS) Logic, Comparison of TTL and CMOS families.

Choice: Unit-II and Unit-III

Text Books:

1. "Digital Logic and Computer Design", M. Morris Mano, Prentice Hall – Pearson Education.
2. "Digital Principles and Design", Donald Givone, Tata Mc Graw Hill.

Reference Books:

1. "Fundamental of Logic Design", Charles Roth Jr., Thomas Learning.
2. "Digital Logic Applications and Principles", John Yarbrough, Pearson Education.

E Books:

1. http://www.panstanford.com/pdf/9789814364591fm.pdf
2. https://easyengineering.net/digital-logic-and-computer-design-by-morris-mano/
3. https://www.sciencedirect.com/book/9780750645829/digital-logic-design
4. https://easyengineering.net/fundamentals-of-digital-circuits-by-anand-kumar/

MOOCs:

1. https://nptel.ac.in/courses/108105113/
2. https://nptel.ac.in/courses/106105185/

LABORATORY EXPERIMENT LIST

Sl. No.	Title of the Experiment
1.	Applications of IC 7483 (Adders, Subtractors and Comparators) (Unit-II)
2.	Multiplexers (using Gates and IC) and their applications (Unit-II)
3.	Decoders/DeMultiplexers (using Gates and IC) and their applications (Unit-II)
4.	BCD to Decimal decoder using 7-segment display (Unit-II)
5.	Verification of MSJK Flip-flop (using Gates and IC 7476) (Unit-III)
6.	Asynchronous counters (using ICs 7476,7490,7493) (Unit-III)
7.	Synchronous Counters (using ICs 7476, 74190/74192) (Unit-III)
8.	Shift registers and their applications (using ICs 7476, 7495) (Unit-III)
9.	Verification of few parameters of TTL (Unit-V)
10.	Verification of few parameters of CMOS (Unit-V)

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Course Title	**FIELD THEORY**				
Course Code	**19ES3GCFTH**	**Credits**	**4**	**L – T – P**	**3:1:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the laws of static Electric and Magnetic fields to study time-varying Electro-magnetic fields and Waves	1	1
CO2	Analyze and solve Electromagnetic problems related to static/time varying fields and also wave propagation in different media	2	1
CO3	Self-learning through listening and comprehension of audio / video lectures related to electro-magnetic fields and waves domain	12	1

UNIT – I **10 Hrs (7L + 3T)**

Introduction to Electrostatics: Introduction to line integral, surface integral, volume integral of vectors, Coulomb's Law (vector form), Electric Field Intensity (vector form), EFI due to different types of charge distributions, Electric Flux Density (EFD), Gauss' Law, Divergence: Electric Flux Density (EFD), Applications of Gauss' Law, Divergence and Divergence Theorem.

UNIT – II **11 Hrs (8L + 3T)**

Energy and Potential: Energy spent in moving a charge in an Electric field, Definition of Potential and Potential Difference (PD), PD due to Point Charge and System of Charge, Potential gradient, Energy Density.

Current and current density: Current and Current Density, Continuity of Current, Conductor Properties and Boundary Conditions.

UNIT – III **08 Hrs (6L + 2T)**

Dielectric: Dielectric materials, boundary conditions, Poisson's and Laplace's equations:

Derivations of Poisson's and Laplace's Equations: Solution for Single Variables, Capacitance of different configurations using Laplace's equation.

UNIT – IV **10 Hrs (8L + 2T)**

Steady Magnetic Field: Biot-Savart Law, Ampere's Circuital Law, Curl, Magnetic Flux, Flux Density, Scalar and Vector Magnetic Potentials, Force on a moving charge, Force on differential current element, Inductance and Mutual Inductance Magnetic Boundary Condition.

UNIT – V **11 Hrs (9L + 2T)**

Time varying fields and Maxwell's equations: Faraday's Law, Displacement Current, Maxwell's Equations in Point and Integral Form, Uniform plane waves, Wave equations, Solution of wave equation, Wave propagation through good dielectric, good conductor, skin depth, Poynting's Theorem.

Choice: Unit-II and Unit-V

Text Books:

1. "Engineering Electromagnetics", William H. Hayt, John A. Buck, M. Jaleel Akhtar, Tata McGraw-Hill, 8th Edition, 2014.
2. "Electromagnetics", Schaum's Outline series, Joseph A. Ediminister, Tata McGraw-Hill, Revised Second Edition, 2014.

Reference Books:

1. "Electromagnetics with Applications", John Krauss and Daniel A Fleisch, McGraw-Hill, 5th Edition, 1999.
2. "Field and Wave Electromagnetics", David K. Chary, Pearson Education Asia, Second Edition 1989, Indian Reprint 2001.
3. "Elements of Electromagnetics", Mathew N. O. Sadiku, Oxford University Press, 2014.

MOOCs:

1. `https://nptel.ac.in/courses/108106073/`
2. `http://qeee.in/coursepack/generate_books/generated_books/1975/`

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Course Title	MODERN SENSORS AND ITS APPLICATIONS				
Course Code	19EC3DCMSA	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand sensor fabrication and characterization techniques	–	–
CO2	Apply the concepts of physics to understand the principle of sensing physical parameters	1	1
CO3	Analyze the working of analog sensors for engineering applications	2	1

UNIT – I **07 Hrs**

Sensor Characteristics: Transfer function, span, accuracy, calibration, hysteresis, nonlinearity, saturation, dead band, resolution, special properties, output impedance, excitation, dynamic characteristics, environmental factors, reliability, application characteristics, and uncertainty.

UNIT – II **08 Hrs**

Physical Principles of Sensing: Capacitance, Piezoelectric Effect, Pyroelectric effect, Peltier effect and Seebeck effect, Hall effect, Thermoelectric effect, Sound waves, Temperature and thermal properties of materials.

UNIT – III **10 Hrs**

Force and Strain: Strain Gauge, Tactile sensors- Membrane switch as a tactile sensor, Active piezoelectric tactile sensor, Piezo electric force sensors.

Pressure Sensors: Concepts of Pressure, Units of Pressure, Mercury Pressure Sensor, Vacuum Sensors – Pirani Gauge, Ionization Gauges, Gas Drag Gauge.

Displacement and Level Sensors: Inductive and Magnetic sensor – LVDT and RVDT, Hall

Effect Sensors.

Acoustic sensor: Resistive and Fiber-optic microphones. Humidity and Moisture sensor: Concept of Humidity, Thermal conductivity and Optical Hygrometers. Light Detectors: Photodiode, Photo transistor, Photo resistor.

UNIT – IV **08 Hrs**

Temperature sensor: Thermoresistive Sensors – RTD, NTC Thermistors and its Computational Models, Thermoelectric Contact sensors – Thermocouple, Semiconductor PN junction sensor, Optical Temperature sensor.

UNIT – V **07 Hrs**

Sensor Materials and Technologies: Materials (Silicon, Plastics, Metals, Ceramics and Glasses), Surface processing: Thermal evaporation and Chemical vapor deposition, Nanotechnology: Photolithography process.

Choice: Unit-III and Unit-IV

Text Books:

1. "Handbook of Modern Sensors: Physics, Designs, and Applications", Jacob Fraden, Springer Publications, Third Edition.
2. "Foundations of MEMS", Chang Liu, Pearson Indian Print, 1st Edition, 2012.
3. "Introduction to Nanotechnology", Charles P. Poole and Frank J. Owens, John Wiley & Sons, 2003.

Reference Books:

1. "Sensors Handbook", Sabrie Soloman, Mc Graw Hill, Second Edition.
2. "A course in Electrical and Electronic Measurement and Instrumentation", A. K. Sawhney, Dhanpat Rai and Sons, New Delhi, 1999.

MOOCs:

1. https://nptel.ac.in/courses/112103174/pdf/mod2.pdf
2. https://www.youtube.com/watch?v=1uPTyjxZzyo
3. http://www.nptelvideos.in/2012/11/industrial-instrumentation.html
4. https://www.nap.edu/read/4782/chapter/4

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Course Title	**MINI PROJECT I**				
Course Code	**19EC3PWMP1**	**Credits**	**1**	**L – T – P**	**0:0:1**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Analyze, design and develop solutions to real-world problems applying the fundamental concepts of electronics learnt from previous and current semesters.	1, 2	1, 2
CO2	Work in a team and Explore the open source tools and resources in solving the problems.	3, 4, 5, 9, 10	1, 2

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Course Title	**CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN RIGHTS**				
Course Code	**19IC3HSCPH**	**Credits**	**1**	**L – T – P**	**1:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand and explain the significance of Indian Constitution as the Fundamental Law of the Land.	6	–
CO2	Analyse the concepts and ideas of Human Rights.	6	–
CO3	Apply the practice of ethical responsibilities and duties to protect the welfare and safety of the public.	8	–

UNIT – I **3 Hrs**

Introduction to Indian Constitution: Historical Background of the Indian Constitution. Framing of the Indian constitution: Role of the Constituent Assembly – Preamble and Salient features of the Constitution of India, Fundamental Rights and its limitations. Fundamental Duties and their significance, Directive Principles of State Policy: Importance and its relevance. Case Studies.

UNIT – II **2 Hrs**

Union Executive and State Executive: The Union Executive – The President and The Vice President, The Prime Minister and The Council of Ministers. The Union Parliament – Lok Sabha & Rajya Sabha.

The Supreme Court of India.

State Executive: The Governors, The Chief Ministers and The Council of Ministers.

State Legislature: Legislative Assembly and Legislative Council. State High Courts.

UNIT – III **2 Hrs**

Election Commission of India, Amendments and Emergency Provisions: Election Commission of India – Powers & Functions – Electoral Process in India. Methods of Constitutional Amendments and their Limitations.

Important Constitutional Amendments: 42nd, 44th, 61st, 74th, 76th, 77th, 86th and 91st. Emergency Provisions. Case Studies.

UNIT – IV **3 Hrs**

Special Constitutional Provisions/Human Rights: Special Constitutional Provisions for Schedule Castes, Schedule Tribes & Other Backward Classes. Women & Children. Case Studies.

Human Rights/values: Meaning and Definitions, Legislative Specific Themes in Human Rights and Functions/ Roles of National Human Rights Commission of India. Human Rights (Amendment Act) 2006

UNIT – V **3 Hrs**

Professional Ethics: Scope and Aims of Engineering Ethics, Responsibilities of Engineers and impediments to responsibilities. Honesty, Integrity and Reliability, Risks – Safety and Liability in Engineering, Case Studies.

Text Books:

1. "An Introduction to Constitution of India and Professional Ethics", Merunandan K. B. and B. R. Venkatesh, Meragu Publications, 3rd edition, 2011.
2. "Constitution of India & Professional Ethics & Human Rights", Phaneesh K. R., Sudha Publications, 10th edition, 2016.

Reference Books:

1. "V.N. Shukla's Constitution of India", Prof. (Dr.) Mahendra Pal Singh, Eastern Book Company, 13th Edition (Revised), 2017, Reprint 2019.
2. "Ethics in Engineering", Mike W. Martin, Roland Schinzinger, McGraw-Hill Education, 4th Edition, February 6, 2004.

E books:

1. https://books.google.co.in/books/about/Constitution_of_India_and_Professional_E.html?id=VcvuVt-d88QC "Constitution of India and Professional Ethics", by G. B. Reddy and Mohd. Suhaib, I.K. International Publishing House Pvt. Ltd., 2006.
2. http://www.scribd.com/doc/82372282/Indian-Constitution-M-Raja-Ram-2009#scribd "Indian Constitution", M. Raja Ram, New Age International Pvt. Limited, 2009.

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Course Title	**ADDITIONAL MATHEMATICS – I (Common to all branches for III Semester Lateral Entry Students)**				
Course Code	**19MA3IMMAT**	**Credits**	**00**	**L – T – P**	**3:1:0**

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the basic concepts of differentiation and integration.	–	–
CO2	Apply the concepts of polar curves and multivariate calculus.	1	–
CO3	Apply analytical techniques to compute solutions of first and higher order ordinary differential equations.	1	–

UNIT – I **09 Hrs (7L + 2T)**

DIFFERENTIAL AND INTEGRAL CALCULUS

List of standard derivatives including hyperbolic functions, rules of differentiation. Taylor's and Maclaurin's series expansion for functions of single variable. List of standard integrals, integration by parts. Definite integrals – problems.

UNIT – II **10 Hrs (7L + 3T)**

POLAR COORDINATES AND PARTIAL DERIVATIVES

Polar curves: Polar coordinates, angle between radius vector and tangent, angle between two polar curves. Partial differentiation. Total differentiation-Composite and Implicit functions. Jacobians and their properties (without proof) – Problems.

UNIT – III **10 Hrs (7L + 3T)**

VECTOR CALCULUS AND ORTHOGONAL CURVILINEAR COORDINATES

Recapitulation of scalars, vectors and operation on scalars and vectors. Scalar and vector point functions. Del operator, gradient-directional derivative, divergence, curl and Laplacian operator. Vector identities (without proof). Cylindrical and Spherical polar coordinate systems. Expressing a vector point function in cylindrical and spherical systems. Expressions for gradient, divergence, curl and Laplacian in orthogonal curvilinear coordinates.

UNIT – IV **09 Hrs (7L + 2T)**

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS

Introduction to first order differential equations. Linear equation and its solution. Bernoulli's equation and its solution. Exact differential equation and its solution. Orthogonal Trajectories.

UNIT – V **10 Hrs (8L + 2T)**

SECOND AND HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS

Ordinary differential equations with constant coefficients: Homogeneous differential equations, non-homogeneous differential equations – Particular integral for functions of the type $f(x) = e^{ax}$, $\sin(ax)$, $\cos(ax)$, x^n, method of variation of parameters, Cauchy's and Legendre linear differential equations.

Text Books:

1. "Higher Engineering Mathematics", B. S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. "Advanced Engineering Mathematics", 4th edition, 2011, Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

Reference Books:

1. "Advanced Engineering Mathematics", Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley- India.
2. "Higher Engineering Mathematics", B. V. Ramana, 2007, Tata McGraw Hill.

E books and online course materials:

1. "Engineering Mathematics", K. A. Stroud and Dexter J. Booth, Industrial Press, 2001.
2. `http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y`
3. "Advanced Engineering Mathematics", P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
4. `http://ocw.mit.edu/courses/mathematics/` (online course material)

Online Courses:

1. `https://www.khanacademy.org/Math`
2. `https://www.class-central.com/subject/math` (MOOCs)

IV Semester Syllabus

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Course Title	**ENGINEERING MATHEMATICS – IV (Common to AS/CV/EE/EC/EI/ML/ET)**				
Course Code	**19MA4BSEM4**	**Credits**	**4**	**L – T – P**	**3:1:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Demonstrate an understanding of concepts of statistical analysis and probability distributions.	1	–
CO2	Apply Numerical techniques to solve partial differential equations arising in engineering.	1	–
CO3	Demonstrate an understanding of analytic functions and their application to evaluate integrals.	1	–

UNIT – I **10 Hrs (8L + 2T)**

STATISTICS AND PROBABILITY

Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curve of the form $y = ab^x$. Correlation and regression. Probability distributions: Discrete distribution – Poisson distribution. Continuous distribution– Normal distribution.

UNIT – II **09 Hrs (7L + 2T)**

JOINT PROBABILITY AND MARKOV CHAIN

Joint Probability Distributions: Discrete random variables, Mathematical expectations, Covariance and Correlation.

Markov Chain: Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chain.

UNIT – III **09 Hrs (7L + 2T)**

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

Finite-Difference formulas to partial derivatives. Applications: Solution of one-dimensional heat equation using 2-level formula and Schmidt explicit formula and Crank-Nicolson two-level implicit formula. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme.

UNIT – IV **10 Hrs (7L + 3T)**

COMPLEX ANALYSIS 1: Function of a complex variable, limits, continuity and differentiability of a complex valued function, Analytic functions, properties of analytic functions, Cauchy-Riemann equations in Cartesian and polar form, Construction of analytic functions by Milne-Thomson method, Conformal mapping. Transformations: $w = z^2$, $w = z + \frac{a^2}{z}\,(z \neq 0)$ and Bilinear Transformations.

UNIT – V **10 Hrs (7L + 3T)**

COMPLEX ANALYSIS 2: Complex integration: Line integral, Problems on line integral, Cauchy's theorem, Cauchy's integral formula.

Complex series: Taylor's, Maclaurin's and Laurent's series (without proof).

Zeros, Poles and Residues: Residue theorem (without proof).

Text Books:

1. "Numerical Methods for Engineering", R. P. Kanale and S. C. Chapra, 6th edition, McGraw Hill, Publishers.
2. "Higher Engineering Mathematics", B. V. Ramana, 2007, Tata McGraw Hill.

Reference Books:

1. "Advanced Modern Engineering Mathematics", Glyn James, 3rd edition, 2004, Pearson Education.
2. "Higher Engineering Mathematics", B. S. Grewal, 43rd edition, 2013, Khanna Publishers.

E books and online course materials:

1. https://www.coursera.org/learn/basic-statistics
2. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_statistics_EBook
3. https://ocw.mit.edu/courses/mathematics/18-112-functions-of-a-complex-variable-fall-2008/lecture-notes/
4. https://www.math.ubc.ca/~peirce/M257_316_2012_Lecture_8.pdf

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111105090/ (Probability & statistics: Joint distribution, Testing of Hypothesis)
2. https://nptel.ac.in/courses/111103070/ (Complex Analysis – Analytic functions, Mobius transformation & Residue theorem)
3. https://nptel.ac.in/courses/111107056/ (Complex Analysis – Complex integration, conformal mapping)

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Course Title	**CONTROL SYSTEMS**				
Course Code	**19ES4ESCST**	**Credits**	**4**	**L – T – P**	**3:1:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the knowledge of engineering fundamentals to form mathematical model/s and ob- tain transfer function/state space representation of a system.	1	1
CO2	Analyze the stability of LTI systems in time/frequency domain using different techniques.	2, 5	2
CO3	Present Case study / Seminar on Design of LTI systems in time/frequency domain as a team/an individual	3, 5	3

UNIT – I **10 Hrs (7L + 3T)**

Introduction: Examples of Control Systems, open loop vs Closed loop Systems.

Mathematical Modeling of Linear Systems: Transfer functions, Mechanical Systems, Analogous Systems, Block diagram, Signal Flow graph, Transfer Functions of Lag & Lead Compensators.

UNIT – II **10 Hrs (7L + 3T)**

Controllers & Time response analysis: Step response of first order, second order systems, response specification, steady state error and error constants. Effect of PI, PD and PID controllers on the time response of the system.

UNIT – III **10 Hrs (7L + 3T)**

Stability Analysis: Concept of stability, RH criterion, Applications of RH criterion with limitations.

Root locus technique: Introduction to root locus concepts, Construction rules, Analysis of stability by root locus plot.

UNIT – IV **10 Hrs (7L + 3T)**

Frequency response Analysis: Nyquist plot, Polar plots, Stability Analysis using Nyquist criterion, Bode plots, GM and PM, Relative stability.

UNIT – V **10 Hrs (7L + 3T)**

State Variable Analysis: Concept of state variables, Physical variable model, Phase variable model, Canonical model, Obtaining transfer function from state model.

Choice: Unit-I and Unit-IV

Text Books:

1. "Control Engineering", Nagrath and Gopal, New Age International Publishers.
2. "Engineering Control Systems", Norman S. Nise, John Wiley and Sons, 5th Edition

Reference Books:

1. "Modern Control Engineering", Ogata, Prentice Hall
2. "Automatic Control Systems", B.C Kuo, John Wiley and Sons.

E Books:

1. http://en.wikibooks.org/wiki/Control_Systems
2. http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/#practical-examples-of-open-loop-control-system
3. http://www.facstaff.bucknell.edu/mastascu/eControlHTML/CourseIndex.html

MOOCs:

1. https://onlinecourses.nptel.ac.in/noc22_de09/preview
2. https://www.edx.org/course/

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Course Title	**LINEAR INTEGRATED CIRCUITS**				
Course Code	**19ES4CCLIC**	**Credits**	**4**	**L – T – P**	**3:0:1**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Define, understand and explain the DC and AC performance characteristics of op-amp, applications of op-amp, working of 555 timer and voltage regulators.	1	–
CO2	Apply the knowledge of KVL and KCL to obtain voltage/current/waveforms at different points in analog electronic circuits such as op-amp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators, 555 timers.	1, 2	–
CO3	Analyse analog electronic circuits such as op-amp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators, 555 timers.	2, 3	1
CO4	Design analog electronic circuits such as op-amp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators, 555 timers.	4	1
CO5	Conduct experiments using analog electronic components, electronic instruments to function as amplifiers, comparators, rectifiers, filters, astable and monostable circuits using 555 timer, data converters.	1, 2, 3, 4	1

UNIT – I **8 Hrs**

Operational Amplifier Characteristics: Introduction, Amplifiers in closed loop configuration, DC Characteristics, AC Characteristics, Frequency compensation.

Operational Amplifier Applications: Instrumentation Amplifier, V to I and I to V converter,

Op-amp circuits using Diodes – Half wave rectifier, Full wave rectifier, Peak detector, Sample and hold circuit.

UNIT – II **8 Hrs**

Comparators and Waveform Generators: Introduction, Comparator, Regenerative comparator (Schmitt Trigger), Square wave generator using Astable Multivibrator, Monostable Multivibrator, Triangular wave generator. Sinusoidal oscillators: RC and Wien bridge oscillators.

UNIT – III **8 Hrs**

Voltage Regulators: Introduction, Basics, Linear Voltage Regulator using Op-Amps, IC voltage regulator – 78XX, 79XX, LM317, LM723. Switched-Mode Power Supplies, Comparison between Linear and Switched-Mode Power Supplies.

Active Filters: Introduction, RC Active Filters, First order low pass filter, Second order active filter, Higher order low pass filter, High pass active filter, All pass filter – phase shift lead and lag circuit.

UNIT – IV **8 Hrs**

D/A and A/D Converters: Introduction, Analog and Digital data converter, Specifications of D/A and basic DAC techniques – Weighted resistor DAC, R-2R ladder DAC, A-D Converters: Specifications of A/D converter, Classification of ADCs: The parallel Comparator (Flash) ADC, Counter type ADC, Successive Approximation Converter, Single slope type ADC and Dual slope type ADC, Sigma-delta ADC.

UNIT – V **8 Hrs**

Timers: Functional block diagram of 555, Applications: Astable and Monostable multivibrators, Ramp generator.

Phase locked loops: Introduction, Basic principles, phase detector/comparator, voltage controlled oscillator (VCO), PLL in frequency Multiplication/Division.

Choice: Unit-I and Unit-IV

Text Books:

1. "Linear Integrated Circuits", S. Salivahanan and V. S. Kanchana Bhaaskaran, 2nd Edition, Tata McGraw – Hill Publication.
2. "Linear Integrated Circuits", D Roy Choudhury and Shail B. Jain, New AgePublication

Reference Books:

1. "Opamps and Linear ICs", David A.Bell, Prentice-Hall Publications (New age Publication).

2. "Op-Amps and Linear Integrated Circuits", Ramakanth A. Gayakwad, 4th Edition, PHI.

E Books:

1. https://www.analog.com/en/education/education-library/tutorials/analog-electronics.html
2. https://electronicsforu.com/resources/7-free-ebookstutorials-on-op-amp

MOOCs:

1. https://swayam.gov.in/nd1_noc19_ee39/previewopamppracticalapplications:design,simulationandimplementation by Dr.Hardik J. Pandya, IISc Bengaluru
2. Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware — Reviews and Ratings
3. http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/

LABORATORY EXPERIMENT LIST

Sl. No.	Name of the Experiment
1.	Inverting and non-inverting amplifier, voltage follower
2.	Inverting and non-inverting summing Amplifier
3.	Precision half wave and full wave rectifier
4.	Zero crossing detector and Schmitt trigger
5.	Wein bridge Oscillator
6.	First order active low pass filter
7.	First order active high pass filter
8.	IC 723 as low voltage and high voltage regulators
9.	D to A converter
10.	A to D converter
11.	555 as astable multivibrator
12.	555 as monostable multivibrator

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Course Title	**MICROCONTROLLERS**				
Course Code	**19ES4CCMCS**	**Credits**	**4**	**L – T – P**	**3:0:1**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Understand and explain architecture of microprocessors and microcontrollers, pipelining, addressing modes, data types in Embedded C, serial communication, timer configuration, interrupt handling of microcontroller, and memory expansion.	–	–
CO2	Apply the knowledge of addressing modes and instructions to develop 8051 assembly programs.	1	1
CO3	Analyse the code in assembly / Embedded C for applications of the timer, serial communication and interrupts of 8051	2	1
CO4	Design an 8051 system by interfacing 8051 to external memory , I/O, peripheral devices and external devices.	3, 5	1
CO5	Conduct experiments by simulating assembly and Embedded C code using KEIL IDE and interfacing the hardware modules to 8051 platform	4, 5	1

UNIT – I **8 Hrs**

Fundamentals of Microprocessors: Block diagram approach for Microprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems.

Overview of the 8051 family: The 8051 Architecture Internal Block Diagram, ,address, data and control bus, working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Memory architecture-Harvard and Princeton. Data and Program Memory, Timing diagrams and Execution Cycles, Pipelining.

UNIT – II **8 Hrs**

Instruction Set and Assembly Language Programming: Introduction, Instruction syntax, assembler directives, Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, bit inherent and bit direct addressing, 8051 Instruction set - Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions, Assembly language programs.

UNIT – III **8 Hrs**

Embedded C Programming: C Data Types, Timer and counter programming, Basics of Serial communication, Programming UART for serial communication, 8051 Interrupt programming.

UNIT – IV **8 Hrs**

Memory and I/O Interfacing: 8051 interfacing to external memory- memory address decoding, 8051 interfacing with external ROM, 8051 data memory space, accessing external data memory in 8051 C, interfacing with 8255.

UNIT – V **8 Hrs**

Interfacing Applications: Interfacing 8051 to LCD, Stepper motor, DC Motor, ADC and DAC, Sensor interfacing for control applications.

Choice: Unit-II and Unit-III

Lab Experiments

PART A: The experiments here can be implemented on a simulator using KEIL IDE.

1. Assembly Language Programs to

   (i) Data Transfer Operations
   (ii) Arithmetic, Logical Operations
   (iii) Conditional Operations
   (iv) Bit Manipulations
   (v) Port Functioning
   (vi) Delay operations using Timers

2. Embedded ‘C’ programs for Arithmetic, Logical, Port operations on simulator

PART B: Interfacing of hardware modules to microcontrollers such as

(i) Stepper motor
(ii) Key Board
(iii) LCD
(iv) ADC, DAC

(v) Serial Communication

(vi) Temperature sensor interface for monitoring and control

(vii) Sensing of humidity and Co2 for control applications

The experiments may be implemented using KEIL IDE with embedded C programming. The application examples may be modified on similar lines as mentioned in PARTB (vi) and (vii).

Text Books:

1. "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, Pearson Education, 2007.
2. "Microprocessor Architecture: Programming and Applications with the 8085", R. S. Gaonkar, Penram International Publishing, 1996.

Reference Books:

1. "8051 Microcontroller", Kenneth J. Ayala, Delmar Cengage Learning, 2004.
2. "Embedded System", R. Kamal, McGraw Hill Education, 2009.
3. "Computer Organization and Design: The Hardware/Software Interface", D. A. Patterson and J. H. Hennessy, Morgan Kaufman Publishers, 2013.
4. "Microprocessors & Interfacing", D. V. Hall, McGraw Hill Higher Education, 1991.

MOOCs:

1. `https://nptel.ac.in/courses/117/104/117104072/`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**SIGNALS AND SYSTEMS**				
Course Code	**19ES4CCSAS**	**Credits**	**4**	**L – T – P**	**3:1:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Gain knowledge of mathematical representation of signals and systems in various domains.	–	–
CO2	Apply various properties of transform techniques to solve the continuous and discrete Linear Time Invariant Systems	1	1
CO3	Analyze various methods to categorize the LTI Systems and identify solutions for mathematical representation of systems.	2	1, 2

UNIT – I **11 Hrs (9L + 2T)**

Introduction to Signals: Definitions of a signal, elementary signals, classification of signals and basic operations on signals.

UNIT – II **10 Hrs (8L + 2T)**

Introduction to Systems: Definitions of a system, properties of systems, systems viewed as Interconnections of operations, Differential and difference equation representations and block diagram representations of LTI systems.

UNIT – III **12 Hrs (9L + 3T)**

Impulse Response Representation of LTI Systems: Introduction to impulse response representation, Convolution Sum and Convolution Integral, relation with system properties, Interconnection of LTI systems (properties of convolution).

UNIT – IV **07 Hrs (5L + 2T)**

Application of Fourier Analysis: Fourier representation for Four classes of signals, properties of Fourier transform (proof excluded), frequency response of LTI systems, solution of difference and differential equations.

UNIT – V **10 Hrs (7L + 3T)**

Applications of z-transforms: Introduction to bilateral and unilateral z-transforms, Properties (proof excluded), Analysis of LTI Systems: Transfer function and structures for implementing LTI system, Causality and stability, frequency response, and solution of difference equations.

Choice: Unit-I and Unit-III

Text Books:

1. "Signals and Systems", Simon Haykin and Barry Van Veen, John Wiley & Sons, 2001, Reprint 2002.
2. "Signals and Systems", Alan V Oppenheim, Alan S. Willsky and A. Hamid Nawab, Pearson Education Asia/PHI, 2nd edition, 1997, Indian Reprint 2002.

Reference Books:

1. "Signals and Systems", H. P. Hsu and R. Ranjan, Scham's Outline Series, TMH, 2006.
2. "Linear Systems and Signals", B. P. Lathi, Oxford University Press, 2005.
3. "Signals and Systems", Ganesh Rao and Satish Tunga, Sanguine Technical Publishers, 2004.

MOOCs:

1. NPTEL lecture Video on Signals and Systems by Prof. S. C. Dutt Roy, `http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html`
2. NPTEL lecture Video on Signals and Systems by Prof. T.K. Basu, IIT Kharagpur `http://www.nptel.ac.in/courses/108105065/`
3. NPTEL online Course Modules–IIT Bombay, Signals and Systems `http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/TOC-M1.html`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**HDL PROGRAMMING**				
Course Code	**19EC4PCHDL**	**Credits**	**3**	**L – T – P**	**2:1:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the knowledge of HDL for modeling and functional verification of Digital circuits.	1	3
CO2	Analyze digital circuits using suitable Verliog HDL modeling.	2	3
CO3	Design and synthesize a digital circuit for complex systems using Verilog HDL and state machines.	3	3
CO4	Program and synthesize a given application/problem statement using EDA tools.	5	3

UNIT – I **10 Hrs (6L + 4T)**

Introduction: VLSI design flow, importance of HDLs, Verilog HDL and Design, Methodologies, modules, instances, components of simulation, example, basic concepts.

Modules and Ports: Modules, ports, Rules.

UNIT – II **08 Hrs (6L + 2T)**

Gate Level Modeling: Gate Types, Gate Delays, Examples.

Dataflow Modeling: Continuous assignment, Delays, Expressions, Operators, Operands, Operator Types and Examples.

UNIT – III **08 Hrs (6L + 2T)**

Behavioural Modeling: Structured procedure, procedural assignments, timing control, conditional statements, multi way branching, loops, sequential and parallel blocks, generate blocks, Examples.

Tasks and Functions: Difference between task and functions, Examples.

UNIT – IV **07 Hrs (5L + 2T)**

Logic Synthesis with Verilog HDL: Logic synthesis, Verilog HDL Synthesis, Interpretation of Verilog Constructs, Synthesis Design flow, examples, verification of the gate level netlist, modeling tips for logic synthesis.

UNIT – V **07 Hrs (5L + 2T)**

Synchronous sequential circuits: Moore and Mealy FSM, Design and Implementation of Sequence detector, Serial Adder, Code Converter.

FPGA based Systems: Introduction, Basic concepts, Digital design with FPGAs, FPGA based system design.

Choice: Unit-III and Unit-V

Text Books:

1. "Verilog HDL-A Guide to Digital Design and Synthesis", Sameer Palnitkar, 2nd Edition, Pearson Edition 2003.

Reference Books:

1. "Fundamentals of Digital Logic with Verilog Design", Stephan Brown and Zvonk Vranesic, 2nd Edition, McGraw-Hill, 2008.

E books:

1. 1.http://access.ee.ntu.edu.tw/course/dsd_99second/2011_lecture/W2_HDL_Fundamentals_2011-03-02.pdf
2. http://www.ics.uci.edu/~alexv/154/VHDL-Cookbook.pdf
3. http://ece.niu.edu.tw/~chu/download/fpga/verilog.pdf

MOOCs:

1. Electronic Design Automation: http://nptel.ac.in/courses/106105083/
2. Digital System Design with PLDs and FPGAs http://nptel.ac.in/courses/117108040/ Fundamentals of HDL (Lecture #008)
3. https://www.youtube.com/watch?v=rdAPXzxeaxs&index=8&list=PLE3BC3EBC9CE15FB0

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**ENVIRONMENTAL STUDIES**				
Course Code	**20HS4ICEVS**	**Credits**	**1**	**L – T – P**	**1:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**50 Marks (100% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Discuss the components and impacts of human activities on environment.	7	–
CO2	Apply the environmental concepts for conservation and protection of natural resources.	1	–
CO3	Identify and establish relationship between social, economic and ethical values from environmental perspectives.	6	–

UNIT – I **6 Hrs**

Introduction to Environment: Definition, About the Earth, Earth's Structure, Atmosphere, Parts of Atmosphere: Hydrosphere, Lithosphere and Biosphere.

Ecology & Ecosystem, Balanced ecosystem, Types of Ecosystem.

Human activities - Food, Shelter, Economic & Social Security.

Effects of Human activities on Environment: Agriculture, Housing, Industries, Mining and Transportation activities.

Environmental Impact Assessment (EIA)

UNIT – II **4 Hrs**

Natural Resources: Definition, Renewable and Non-Renewable sources.

Major Natural Resources:

(i) Water resources, its availability, quality, water borne & water induced diseases

(ii) Mineral resources

(iii) Forest resources

Material cycles: Carbon, Nitrogen and Sulphur cycles.

UNIT – III **4 Hrs**

Energy Resources: Conventional and Non-conventional energy resources: Hydroelectric, Wind power, Solar, Biogas.

Fossil fuel based energy resources: Coal, Oil & Gas.

Nuclear power, Hydrogen as an alternate future source of energy.

UNIT – IV **4 Hrs**

Environmental Pollution: Introduction, Types of pollution:

(i) Water pollution: Definition, types, sources, effects, control of water pollution.

(ii) Land pollution: Definition, types, sources, effects, Solid waste management.

(iii) Noise pollution: Definition, sources, effects and control of noise pollution.

UNIT – V **6 Hrs**

Current environmental issues & importance:

Population growth effects & Control, Climatic changes, Global warming.

Acid rain, Ozone layer depletion & effects Environmental protection, Role of Government, Legal aspects.

Environmental protection: Initiatives by Non-Government. Organizations (NGO's), Environmental Education, Women education.

Text Books:

1. "Environmental studies", Dr. Geetha Balakrishanan (Revised Edition).
2. "Ecology", Subramanyam (Tata McGraw Hill Publication).
3. "Environmental studies", Dr. J. P. Sharma (Third edition).
4. "Environmental studies", Smriti Srivastav.

Reference Books:

1. "Environmental studies", Benny Joseph.
2. "Environmental studies", Dr. D. L. Manunath.

Learning Resources:

1. NPTEL (Open Sources / power-point and visuals)
2. Ecological studies / IITR / Open Sources
3. Ministry of Environment and forest & wildlife.

MOOCs:

1. `https://www.coursera.org/course/sustain`

B.M.S. College of Engineering, Bengaluru – 19

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Course Title	**ADDITIONAL MATHEMATICS – II (Common to all branches for IV Semester Lateral Entry students)**				
Course Code	**19MA4IMMAT**	**Credits**	**00**	**L – T – P**	**3:1:0**

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Use Laplace transforms to solve differential equations.	1	–
CO2	Apply multiple integrals of plane figures to compute areas and volume.	1	–
CO3	Use Gamma and Beta functions to evaluate integrals.	1	–
CO4	Ability to understand the use of integral calculus in scalar and vector fields.	1	–

UNIT – I **09 Hrs (7L + 2T)**

LAPLACE TRANSORMS

Laplace transforms of standard functions. Properties and problems. Laplace Transform of Periodic functions with plotting, unit step function and dirac-delta function.

UNIT – II **10 Hrs (7L + 3T)**

INVERSE LAPLACE TRANSFORMS

Inverse Laplace transforms of standard functions. Properties and problems. Solution of ODE-Initial and Boundary value Problems.

UNIT – III **11 Hrs (8L + 3T)**

DOUBLE INTEGRALS

Evaluation of double integral. Change of order of integration. Change of variables to polar coordinates. Application: Area.

UNIT – IV **09 Hrs (7L + 2T)**

TRIPLE INTEGRALS AND IMPROPER INTEGRALS

Evaluation of triple integral. Application: Volume. Beta and Gamma functions-definition, relation between Beta and Gamma functions, properties and problems.

UNIT – V **09 Hrs (7L + 2T)**

VECTOR INTEGRATION

Line integral, Green's theorem, Stokes' theorem and Gauss divergence theorem.

Text Books:

1. "Higher Engineering Mathematics", B. S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. "Higher Engineering Mathematics", B. V. Ramana, 2007, Tata McGraw Hill.

Reference Books:

1. "Advanced Engineering Mathematics", Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th Edition, 2014, Wiley-India.
2. "Advanced Engineering Mathematics", 4th edition, 2011, Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

E books and online course materials:

1. "Engineering Mathematics", K. A. Stroud and Dexter J. Booth, Industrial Press, 2001.
2. `http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y`
3. "Advanced Engineering Mathematics", P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
4. `http://ocw.mit.edu/courses/mathematics/` (online course material)

Online Courses:

1. `https://www.khanacademy.org/Math`
2. `https://www.class-central.com/subject/math` (MOOCs)
3. E-learning: `www.vtu.ac.in`

V Semester Syllabus

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**COMMUNICATION THEORY I**				
Course Code	**19EC5PCCT1**	**Credits**	**4**	**L – T – P**	**3:0:1**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: Signals and Systems.

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply various concepts of theorems and Transforms for computing parameters of Communication systems.	1	1, 2
CO2	Analyze performance of different types of Analog modulation Techniques for a given set of parameters.	2	1, 2
CO3	Design Analog Communication subsystems for given set of specifications.	3	1, 2
CO4	Simulate and conduct experiments on different types of Analog communication subsystems.	4, 5	1, 2, 3
CO5	Involve in independent/team learning, Communicate effectively and engage in life-long learning	9, 10,12	1, 2, 3

UNIT – I **8 Hrs**

Random process: Random variables, Gaussian distribution, Random processes, Stationarity, Mean, Correlation and Covariance functions, Transmission of random signals through linear filters.

Amplitude modulation (AM):Time-domain and Frequency domain representation, Generation and Detection.

DSBSC: Time-domain and Frequency domain representation, Generation and Detection. Quadrature carrier multiplexing.

UNIT – II **8 Hrs**

Hilbert transform: Properties of Hilbert transform, Pre-envelope, Canonical representation of

band pass signals.

Single sideband modulation: Frequency domain description, Generation and Demodulation.

Vestigial sideband modulation (VSB): Time and Frequency domain description, Generation and detection. Frequency translation, Frequency division multiplexing.

UNIT – III **8 Hrs**

Angle modulation: Basic concepts, FM, Narrow band FM, Wide band FM, Transmission bandwidth of FM waves. Generation of FM waves: Indirect FM, Direct FM. Demodulation of FM waves: Balanced frequency discriminator, Zero-crossing detector, Phase-locked loop, FM stereo multiplexing.

UNIT – IV **8 Hrs**

Noise in analog modulation: Introduction, Shot noise, Thermal noise, White noise, Narrow band noise, Representation of noise in terms of In-Phase and Quadrature components, Representation of noise in terms of Envelope and Phase components.

Noise in AM receivers: Signal to Noise Ratio, AM receiver model, SNR in Coherent Reception, Noise in AM receivers using Envelop Detection, FM receiver model, noise in FM reception, FM threshold effect, Pre-emphasis and De-emphasis in FM.

UNIT – V **7 Hrs**

Sampling Process: Sampling Theorem, Quadrature Sampling of Band pass signals, Practical aspects of sampling and signal recovery, PAM – TDM .

Choice: Unit-I and Unit-III

Text Books:

1. "An Introduction to Analog and Digial Communications", Simon Haykin, Wiley, 2003.
2. "Communication Systems", (4/e), Simon Haykin, Wiley, 2001.
3. "Digital Communication", Simon Haykin, Wiley 2009.

Reference Books:

1. "Communication Systems Engineering", (2/e), John G Proakis and Masoud Salehi, Pearson, 2015.
2. "Digital and Analog Communication Systems", K Sam Shanmugam, Wiley, 1994

E Books:

1. "An Introduction to Analog and Digial Communications", Simon Haykin, Wiley, 2003. https://www.wiley.com/en-us/An+Introduction+to+Analog+and+Digital+Communications%2C+2nd+Edition-p-9780470460870
2. "Communication Systems", (4/e), Simon Haykin, Wiley, 2001. https://ict.iitk.ac.in/wp-content/uploads/EE320A-Principles-Of-Communication-CommunicationSystems-4ed-Haykin.pdf

3. "Digital Communication", Simon Haykin, Wiley 2009. https://www.wiley.com/en-in/search?pq=digital%20communication%20haykin%7Crelevance

MOOCs:

1. http://nptel.ac.in/courses/117102059/1
2. https://nptel.ac.in/courses/117/105/117105143/

LABORATORY EXPERIMENT LIST

Sl. No.	Title of the Experiment
1.	Conduction of 2nd order filters.
2.	Conduction of mixer.
3.	Generation and detection of AM, DSBSC waves.
4.	FM wave generation.
5.	Generation and detection of PAM.
6.	TDM and Demultiplexing.
7.	Verification of sampling theorem.

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**FUNDAMENTALS OF VLSI**				
Course Code	**19EC5PCFOV**	**Credits**	**3**	**L – T – P**	**3:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: Basic concepts of MOSFETs

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the knowledge of CMOS technology to construct and analyze array subsystems like memories.	1	3
CO2	Comprehend long channel I-V characteristics and short-channel effects of MOSFETs, and thereby analyze the DC transfer characteristics CMOS circuits.	2, 5, 9, 10	3
CO3	Design CMOS based combinational and sequential circuits for given specifications.	3, 5, 9, 10	3

UNIT – I **8 Hrs**

VLSI design flow: Design Partitioning, Design Verification, Fabrication, Packaging and Testing. MOS Transistor: Introduction, Long Channel I-V characteristics, C-V Characteristics, Simple MOS Capacitance Models, Detailed MOS Gate Capacitance Model, Non ideal I-V Effects.

UNIT – II **8 Hrs**

CMOS Processing Technology: CMOS Technologies, Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO2), Isolation, Gate Oxide, Gate and Source/ Drain Formations, Contacts and Metallization, Passivation, Metrology.CMOS Fabrication and Layout: Inverter Cross-Section, Fabrication Process, Layout Design Rules, Gate Layouts, and Stick Diagrams. CMOS Process enhancements – SOI, FINFETS, Carbon nanotube transistor, 3D–IC.

UNIT – III **8 Hrs**

DC Transfer Characteristics: Static CMOS Inverter DC Characteristics, Beta Ratio Effect, Noise Margin, Pass Transistor DC Characteristics. Combinational Circuit Design: CMOS Logic, Inverter, NAND Gate, NOR Gate CMOS, Logic Gates, The Compound Gates, Pass Transistors and Transmission Gates, Tristate buffer, Multiplexers.

UNIT – IV **8 Hrs**

Sequential MOS logic circuitry: Behavior of Bistable element, SR Latch Circuitry, Clocked latch and Flip Flop Circuitry (SR and JK), CMOS D-Latch and Edge Triggered Flip-Flop.

Sequencing Static Circuits: Sequencing Methods, Max-Delay Constraints, Min-Delay Constraints, Time Borrowing, Clock Skew, Characterizing Sequencing Element delays.

UNIT – V **7 Hrs**

Array Sub system: SRAM: SRAM Cells, Row Circuitry, Column Circuitry. DRAM: Subarray Architectures, Column Circuitry, Embedded DRAM. Read-Only Memory: Programmable ROMs, NAND ROMs, Flash. Serial Access Memories.

Choice: Unit-II and Unit-IV

Text Books:

1. "CMOS VLSI Design", Neil H. E. Weste and David Harris, Pearson Education, 4th Edition, 2011, ISBN: 0-321-54774-8.
2. "CMOS Digital Integrated Circuits", Sung-Mo Kang and Yusuf Leblebici, Tata McGrawHill, 3rd Edition, ISBN: 0-7923-7246-8.

Reference Books:

1. "Basic VLSI Design", Douglas. A. Pucknell and Kamaran Eshraghian, PHI, 3rd Edition, 2010, ISBN: 0-321-26977-2.
2. "Introduction to VLSI Circuits & Systems", John P. Uyemura, Wiley India Edition.

E books and online course materials:

1. `http://swarm.cs.pub.ro/~mbarbulescu/SMPA/CMOS-VLSI-design.pdf`

MOOCs:

1. `https://nptel.ac.in/courses/117101058/`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	ANTENNA THEORY				
Course Code	19EC5PCANT	Credits	4	L – T – P	3:1:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic knowledge of Electromagnetic Fields and Waves

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the concepts and properties of Electromagnetism to obtain parameters of antennas and Wave Propagation	1	2
CO2	Analyze different types of antennas for various applications	2	2
CO3	Present Case study / Seminar on Advanced topics / Antenna Design as an individual/team	5, 6, 10	2

UNIT – I **10 Hrs (7L+3T)**

Antenna Basics: Introduction, Physical concept of radiation, Patterns, beam area, Power theorem and its application radiation Intensity, beam efficiency, directivity and gain, directivity and resolution, antenna apertures, effective height, radio communication Link, Antenna field zones, polarization, reciprocity, bandwidth, radiation efficiency, antenna temperature and antenna impedance.

UNIT – II **10 Hrs (7L+3T)**

Short electric dipole, fields of a short dipole, radiation resistance of short electric dipole, the thin linear antenna, radiation resistance of half wave dipole, folded dipole antennas, Loop antenna: Introduction, small loop, far field patterns of small loop, far field patterns of circular Loop, radiation resistance and directivity.

UNIT – III **11 Hrs (8L+3T)**

Point Sources & Arrays: Introduction, Array of isotropic point sources- different cases, non-isotropic sources and the principle of pattern multiplication, linear arrays of n elements of

equal amplitude and spacing, Null Directions for Arrays of n Isotropic Point Sources of Equal Amplitude and Spacing, Linear broadside arrays with non-uniform amplitude distributions-general condition. Introduction to Phased arrays.

UNIT – IV **11 Hrs (8L+3T)**

Slot Antenna: Slot antenna, Babinet's Principle and complementary antennas. Horn Antennas: Types, Fermat's Principle, Optimum Horns, Design Considerations of Pyramidal Horns, Illustrative Problems. Microstrip antennas: Introduction, Salient Features & its applications Rectangular Microstrip Antennas, Feed Methods, Smart Antennas.

UNIT – V **10 Hrs (7L+3T)**

Helical antennas: Introduction, Helical Geometry, The Helix Modes, Practical Design Considerations for the Monofilar Axial-Mode Helical Antenna. Reflector Antennas: Introduction, the Parabola-General Properties, the Paraboloidal Reflector, Patterns of Large Circular Apertures with Uniform Illumination, Reflector Types, Feed Methods for Parabolic Reflectors, Antennas for Various Applications MW Radio, Cell Phones Cell Towers, Satellite and Defence Communications

Choice: Unit-III and Unit-IV

Text Books:

1. "Antennas and Wave Propagation", John D Kraus, R. J. Marhefka and Ahmed S. Khan, Tata McGraw Hiill India, 2006, Fourth Edition.

Reference Books:

1. "Antenna Theory", Constantine A Balanis, John Wiley & Sons, 2004, Second Edition.
2. "Antennas and Propagation for Wireless Communication systems", Simon R Saunders and Alejandro Aragon-Zavala, Wiley-India, 2nd Edition.
3. "Antennas and Wave Propagation", A. R. Harish and M. Sachidananda, Oxford University Press 2007, Seventh impression 2011.

E books:

1. "Introduction to Smart Antennas", Constantine A. Balanis and Panayiotis I. Ioannides. https://doi.org/10.2200/S00079ED1V01Y200612ANT005
2. "Antennas for Satellite Communications", Eric Amyotte and Luís Martins Camelo. https://onlinelibrary.wiley.com/doi/10.1002/9781119945147.ch12

MOOCs:

1. https://www.classcentral.com/course/swayam-antennas-7924
2. https://www.coursera.org/lecture/satellite-communications/antennas-BQhQ6
3. https://nptel.ac.in/courses/108/101/108101092/
4. https://www.classcentral.com/course/swayam-transmission-lines-and-electromagnetic-waves-17827

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Course Title	**DIGITAL SIGNAL PROCESSING**				
Course Code	**19EC5CCDSP**	**Credits**	**4**	**L – T – P**	**3:0:1**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: Linear algebra, Complex numbers, Fourier Analysis, Laplace Transform. Knowledge of Signals and Systems.

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the concepts of transform techniques in realizing Discrete time signal and Digital filters	1	1
CO2	Analyze various transform techniques for discrete time signals and various methods to design digital Filter	2	1
CO3	Design of Analog and Digital Filters for given specifications	3	1
CO4	Simulation and verification of various transform techniques Filter Design and Multirate Signal Processing	4, 5, 9, 10	1, 3

UNIT – I **8 Hrs**

Introduction to DSP, Frequency-domain Sampling, DFT, IDFT, DFT as a Linear Transformation (Matrix formulation), Properties of DFT: Periodicity, Linearity, Circular Time shifting, Circular Frequency Shifting, Circular Time Reversal, Conjugation and Conjugate Symmetry (Symmetry properties), Duality, Circular Convolution (Multiplication of two DFTs), Circular correlation, Multiplication (or Modulation) property, Parseval's Relation.

UNIT – II **8 Hrs**

Use of DFT in linear filtering, Linear convolution of two finite duration sequences, Overlap-add and Overlap-save methods. Relation between DFT and other transforms. Direct computation of DFT. Necessity for efficient computation of DFT. Radix 2 Fast Fourier Transform (FFT) algorithm for DFT computation. Decimation in time algorithm, decimation in

frequency algorithms. Radix 2 FFT algorithm for computationof Inverse Discrete Fourier Transform (IDFT).

UNIT – III **8 Hrs**

Introduction to realization of digital systems, Block diagram representation, Realization of Infinite Impulse Response (IIR) systems: Parallel form, Cascade form. Introduction to IIR filters, Pole zero placement method for simple IIR Filters, Impulse invariant and Bilinear Transformations, Design of analog Butterworth and Chebyshev filters, Design of Digital Butterworth and Chebyshev filters.

UNIT – IV **8 Hrs**

Realization of Finite Impulse Response (FIR) systems: Direct Form, Linear Phase Form. Introduction to FIR filters, Frequency response of ideal digital low pass filter, High pass filter, Frequency sampling technique of designing FIR filters, Windowing design of FIR filters using Rectangular, Triangular and Hamming windows.

UNIT – V **7 Hrs**

Application of digital filters in noise cancellation: Limitations of Linear filters, Random noise cancellation, Adaptive filters, LMS Algorithm, Applications. Decimation by a factor D, Interpolation by a factor I, Sampling conversion by a Rational factor I/D. Introduction to Multi-rate Digital Signal Processing.

Choice: Unit-I and Unit-III

Text Books:

1. "Digital Signal Processing: Principles, Algorithms and Applications", John G. Proakis and Dimitris K. Manolakis, Pearson education/PHI, 4th Edition.
2. "Digital Signal Processing", Tarun Kumar Rawat, Oxford University Press, December 2014.

Reference Books:

1. "Fundamentals of Digital Signal Processing", Lonnie Ludeman, John Wiley & Sons, Wiley International 1st Edition, 1988.
2. "Discrete-Time Signal Processing", Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, Prentice-Hall Signal Processing Series, 2nd Edition, 1999.
3. "Understanding Digital Signal Processing", Richard G. Lyons, Prentice Hall, 2nd Edition, 2004.
4. "Digital Signal Processing: Fundamentals and Applications", Li Tan, Academic Press, 1st Edition 2007.
5. "Schaum's Outline of Digital Signal Processing", Monson Hayes, McGraw- Hill, 1st edition, 1998.

E Books:

1. https://www.amazon.in/Digital-Signal-Processing-Tarun-Kumar/dp/0198081936
2. https://www.amazon.com/Digital-Signal-Processing-John-Proakis/dp/0131873741

MOOCs:

1. https://nptel.ac.in/courses/117/102/117102060/
2. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ee05/

LABORATORY EXPERIMENT LIST

Sl. No.	Title of the Experiment
1.	Display of basic elementary signals
2.	Verification of Sampling theorem
3.	Basic operations on sequences (shifting, folding, time scaling and multiplication)
4.	Linear and circular convolution
5.	Auto-correlation and Cross-correlation
6.	FFT of a Sequence
7.	Linear convolution and correlation using FFT algorithm
8.	Design of IIR filters: Low pass, High pass
9.	FIR Filter design: Low pass
10.	FIR filter design using Hamming window for the given order and cut-off frequency
11.	Study of Adaptive filter using LMS Algorithm. Interpolation and Decimation

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	COMPUTER ARCHITECTURE				
Course Code	19EC5PE1CA	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Understanding of Digital Electronics, Basic knowledge of Microcontroller, Basic Programming skills.

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of the hardware and software systems of computer to develop efficient coding for sequential and pipeline architectures.	1	3
CO2	Analyze various aspects of code optimization, storage technologies and impact of cache memory on the program on modern processors.	2	3
CO3	Analyze the exceptional control flow of program and the compilation process to create executable object files.	2	3
CO4	Communicate on advanced system engineering trends with effective presentations and report writing skills, following professional ethics.	10	3

UNIT – I **7 Hrs**

Fundamentals of Computer Systems: Hardware organization of a system, Operating system: Processes, Threads, Virtual memory and File system, Concurrency and parallelism: Instruction level, Data level and Thread level parallelism, Importance of abstractions in a computer system.

UNIT – II **8 Hrs**

Processor Architecture: Y86 instruction set architecture: Instructions, Instruction encoding, CISC & RISC instruction set, Y86 exceptions, Y86 programs, Sequential Y86 implementations, General principles of pipelining.

UNIT – III **9 Hrs**

Optimizing Program Performance: Capabilities and limitations of optimizing compilers, Expressing Program Performance, Eliminating loop inefficiencies and memory references, Reducing procedure calls, Loop unrolling, Enhancing parallelism.

UNIT – IV **8 Hrs**

The Memory Hierarchy: Storage Technologies, Locality, Memory Hierarchy, Cache Memories, Virtual Memory and Virtual Machines, Writing Cache Friendly Code, The impact of Cache on Program Performance.

UNIT – V **7 Hrs**

Running Programs on a System: Compiler Drivers, Static Linking, Object Files, Loading Executable Object Files.

Exceptional Control Flow: Exceptions, Exception handling, Classes of Exceptions.

Choice: Unit-III and Unit-IV

Text Books:

1. "Computer Systems: A Programmer's Perspective", Randal E. Bryant and David R. O'Hallaron, 2nd edition, Prentice Hall.
2. "Computer Architecture: A Quantitative Approach", John L. Hennessey and David A. Patterson, 4th Edition, Elsevier.

Reference Books:

1. "Computer Organization and Architecture", William Stallings, Prentice Hall, 6th Edition, 2003.
2. "Computer Architecture: From Microprocessors to Super Computers", Behrooz Parhami, Oxford University Press, 2010.

E Books:

1. `http://www.freebookcentre.net/CompuScience/Free-Computer-Architecture-Books-Download.html`

MOOCs:

1. `https://www.mooc-list.com/course/computer-architecture-coursera`

NOTE: This course content can be supplemented by practical experimentation in a simulator environment for clear understanding.

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Course Title	ADVANCED DIGITAL LOGIC DESIGN				
Course Code	19EC5PE1AD	Credits	3	L – T – P	2:1:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Fundamentals of VLSI, Digital Electronics Circuit Design, HDL Programming.

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the concepts of Digital Design to create digital building blocks using Verilog.	1	3
CO2	Analyze the RTL timing reports for violations and synthesize to generate gate level netlist.	2	3
CO3	Design of RTL using finite state machines along with design optimizations	3	3

UNIT – I **9 Hrs**

Logic Design Using Verilog: Moore's law, Technology Scaling, Die size growth, Frequency, Power dissipation, Power density, Challenges in digital design, Design metrics, and Cost of Integrated circuits, Digital Combinational & Sequential circuits, Modules, Nets, Values, Comments, Arrays in Verilog, Delays, Parameterized designs, Procedural blocks, Blocking and Non-Blocking Assignments, Looping, Flow Control, Task, Function, Basic test bench generation and Simulation, Verilog modeling of combinational and sequential logic.

UNIT – II **8 Hrs**

Principles of RTL Design: Verilog Coding Concepts, Verilog coding guidelines: Combinational, Sequential, FSM. General Guidelines, Synthesizable Verilog Constructs, Sensitivity List, Verilog Events, RTL Design Challenges.

UNIT – III **6 Hrs**

Introduction to timing concepts: Setup and hold times. Setup and hold time equalities and

inequalities, Timing paths. Static timing delay calculation for basic flip flop & sequential circuits, Clock Domain Crossing.

UNIT – IV **7 Hrs**

Synthesis, Libraries and Technology Mapping: Introduction to Synthesis, Logical synthesis of basic combinational and sequential circuits, Synthesis Methodologies, Pre and post synthesis mismatch, Translation, mapping and optimization. Overview of Libraries, Design constraints, Importance of wire load models.

UNIT – V **9 Hrs**

Design and simulation of Finite state machines: FSM Design: Overlapping and non-overlapping Mealy and Moore state machine design.

Choice: Unit-I and Unit-V

Text Books:

1. "Digital Design", Morris Mano M, 4th Edition.
2. "Verilog HDL: A Guide to Digital Design and Synthesis", Samir Palnitkar, 2nd Edition.
3. "Verilog HDL Synthesis: A Practical Primer", J. Bhasker.
4. "Fundamentals of Digital Circuits", A. Anand Kumar, 2nd Edition.
5. "Principles of VLSI RTL Design: A Practical Guide", Sanjay Churiwala and Sapan Garg, 2011.

Reference Websites:

1. `www.asic-world.com`
2. `www.testbench.in`
3. `http://www.vlsi-expert.com/2011/03/static-timing-analysis-sta-basic-timing.html`

Online material: Seer Academy recordings

E Books:

1. `https://www.freebookcentre.net/Electronics/Logic-Design-Books.html`

MOOCs:

1. `https://nptel.ac.in/courses/117106092/`

NOTE: The Course will be supplemented by hands-on lab sessions using Cadence EDA tools.

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Course Title	PROBABILITY AND STATISTICS				
Course Code	19EC5PE1PS	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic Calculus

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Demonstrate and apply the knowledge of probability, random variables and stochastic processes	1	1
CO2	Understand the tools of statistics and apply them to real life scenarios and data	1, 2	1
CO3	Select an appropriate case study from the domain of electronics and communication engineering and effectively analyze and evaluate its various aspects using the tools learnt in this course	2, 4	1

UNIT – I **8 Hrs**

Introduction: Overview of Probability theory, Continuous type and discrete type random variables, Joint distribution, Expectation operator, Correlation and Covariance, Markov chains, Numerical examples and Engineering applications.

UNIT – II **7 Hrs**

Random Processes: Introduction and classification, Mean and Autocorrelation functions, Stationarity, Strict sense and Wide sense stationarity, Ergodicity, Gaussian process.

UNIT – III **8 Hrs**

Statistics: Curve Fitting, Principle of Least Squares, Correlation and Regression, Confidence Intervals, Descriptive Statistics – Graphical Representation, Measures of Location and Variability.

UNIT – IV **8 Hrs**

Sampling Theory: Introduction to Sampling Distributions, Standard Error, Type-I and Type-II Errors, Student's t-Distribution, Chi-Square Distribution as a Test of Goodness of Fit, Central Limit Theorem, Law of Large Numbers.

UNIT – V **8 Hrs**

Estimation: Unbiasedness of Estimator, Hypothesis Testing, Null and Alternate Hypothesis, Maximum Likelihood Estimation, Neyman Pearson Test.

Choice: Unit-III and Unit-IV

Text Books:

1. "An Introduction to Probability and Statistics", V. K. Rohatgi and Md. E. Saleh.
2. "Probability & Statistics for Engineers & Scientists", 8th Edition, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall, Upper Saddle River, NJ 07458, ISBN: 0-13-187711-9 .

Reference Books:

1. "Introduction to Probability and Statistics for Engineers and Scientists", Sheldon M. Ross.
2. "Probability, Random Variables and Stochastic Processes", Athanasios Papoulis and A. O. Pillai, McGraw Hill.

e-References:

1. `https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-041-probabilistic-systems-analysis-and-applied-probability-fall-2010` Probabilistic Systems Analysis and Applied Probability managed by MIT OCW.
2. Probability and Statistics conducted by Prof. Somesh K, IIT Kharagpur NPTEL

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Course Title	OBJECT ORIENTED PROGRAMMING USING C++				
Course Code	19EC5PE1OP	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Programming in C

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand and apply C++ constructs to solve given problem statements	1	1, 2
CO2	Apply knowledge of object-oriented concepts and realize solutions for given problem statements	2	1, 2
CO3	Design efficient solutions to real life problems using generic programming concepts and memory efficient strategies	3	1, 2
CO4	Analyse the given to real time problem/s and develop complete solution/s after carefully selecting one or more of OOP technique/s	3, 5, 9, 10	1, 2

UNIT – I **06 Hrs**

Migration to CPP syntax from C: Tokens, Keywords, Identifiers and Constants, Data types – Basic types of C and reference variables, enum with their importance, Symbolic constants, Variables, Operators, Manipulators, Control statements and loops, Macros, Functions – pass by: value, address and reference, Importance of default values in creating applications.

UNIT – II **10 Hrs**

Classes and Objects: Class definition and declaration, Member functions, Static data members and Member functions, Constructors, Parameterized constructors, Constructors with default values and its importance in applications, Multiple constructors in a class and their working, Copy constructor, Dynamic constructors – Realization and Relevance, Destructors, Arrays of objects, pass and return of objects, Function overloading, Friend functions.

UNIT – III **10 Hrs**

Operator overloading: Overloading unary and binary operators, Overloading using friend functions and its usage, Rules for overloading.

Inheritance: Understand the need with real time examples, Types: Single, Multiple, Hybrid, Hierarchical. Modes of Inheritance: Private, Protected and Public modes and its significance on data access with real world examples.

Pointers to objects, this pointer, pointers to derived classes, virtual functions, run-time polymorphism.

UNIT – IV **06 Hrs**

Templates and exceptions: Need for templates in real life applications, developing container classes with and without template functions, Non-member function templates: Importance and Realization, Overloading template functions, Member function templates and Non-type template arguments. Exception handling: Basics, throwing and catching mechanisms.

UNIT – V **07 Hrs**

IO streams: Managing console I/O operations: C++ streams, C++ stream classes, I/O operations, Managing O/P with manipulators to realize solutions to given problems.

Files: Need for file systems, Classes for file stream operations, Opening and closing a file, Detecting end of file, More about open():file modes, Writing data onto file through any UI.

Choice: Unit-II and Unit-III

Text Books:

1. "Object oriented Programming with C++", E. Balagurusamy, TMH Publications, 4th Edition.
2. "Object oriented Programming in Turbo C++", Robert Lafore, Galgotia Publications.

Reference Books:

1. "Let Us C++", Yashvanth P. Kanetkar, BPB Publications.
2. "Programming With C++", Schaum's series, TMH Publications.
3. Video lectures on BMSCE Studio

E Books:

1. `https://www.w3schools.com/cpp/cpp_oop.asp`
2. `https://www.geeksforgeeks.org/object-oriented-programming-in-cpp/`

MOOCs:

1. Object-Oriented Programming (edX) IITBombay X `https://www.mooc-list.com/course/object-oriented-programming-edx`

NOTE: Header files and exception handlers will be developed as a part of course. Also, applications will be developed as services using modular approach to enrich the learning.

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Course Title	SATELLITE COMMUNICATION				
Course Code	19EC5PE2SC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic concepts of Analog and Digital Communication Systems

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the basic dynamics of satellite communication	–	–
CO2	Evaluate the fundamental design of linking Earth station and the satellite	1	1
CO3	Discuss the various electronics subsystems associated with the satellite communication	–	–
CO4	Outline Satellite applications with the focus on communication and national satellite system	1	1

UNIT – I **8 Hrs**

Orbital mechanics: Orbital parameters, Kepler's laws, Injection velocity and satellite trajectory, Types of Satellite orbits, Orbital perturbations, Satellite stabilization, Orbital effects on satellite's performance.

UNIT – II **8 Hrs**

Satellite Access: Link budget calculations, Atmospheric losses, Ionospheric effects, Rain attenuation, Frequency translation, Error controlling, Multiple access Techniques – FDMA, TDMA, CDMA.

UNIT – III **8 Hrs**

Satellite subsystem: Power supply subsystem, Attitude and Orbit control, Tracking, Telemetry and command subsystem, Structural subsystem, Thermal subsystems, Payload subsystems, Equipment reliability and space qualification.

UNIT – IV **7 Hrs**

Indian Satellite Scenario: Historical developments of satellite communication, PSLV, GSLV, INSAT, GSAT programs, Chandrayaan, Mangalyaan.

UNIT – V **8 Hrs**

Satellite Applications: Global Positioning System, Direct Broadcast satellites, Direct to home broadcast, Digital audio broadcast, World space services, Business TV, Weather Forecasting, Remote Sensing Satellites.

Choice: Unit-II and Unit-V

Text Books:

1. "Satellite Communications", Anil K. Maini and Varsha Agrawal, Wiley India Pvt. Ltd., 2015, ISBN: 978-81-265-2071-8.
2. "Satellite Communications", Dennis Roddy, 4th Edition, McGraw- Hill International Edition, 2006.
3. "Satellite Communications", Timothy Pratt, Charles Bostian and Jeremy Allnutt, 2nd Edition.

Reference Books:

1. "Satellite Communication", Timothy Pratt, Second Edition, John Wiley and sons.
2. "Satellite Communications Systems: Systems, Techniques and Technology", 5th edition, G. Maral, M. Bousquet, Z. Sun, Publisher: John Wiley and sons.
3. "The Satellite Communication Applications Handbook", Bruce R. Elbert, Artech House, 2004.

MOOCs:

1. https://www.coursera.org/learn/satellite-communications
2. https://www.classcentral.com/course/satellitecommunications-6313

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	IMAGE PROCESSING				
Course Code	19EC5PE2IP	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic knowledge of Digital Signal Processing

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply enhancement and restoration techniques to 2D-images in spatial and frequency domain for required visualization	1	1
CO2	Analyze, process and represent an image using various techniques in different domains	2	1
CO3	Interpret image in various data formats by applying image transformation or processing techniques for different applications	4	1

UNIT – I **8 Hrs**

Introduction: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relationships Between Pixels – Neighbours and Connectivity of pixels in image, Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing.

Colour Image Processing: Colour Fundamentals, Colour Models, Pseudo-colour Image Processing.

UNIT – II **8 Hrs**

Image Enhancement:

Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.

Frequency Domain: Preliminary Concepts, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters.

UNIT – III **7 Hrs**

Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering.

UNIT – IV **8 Hrs**

Morphological Analysis: Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms.

Representation and Description: Representation, Boundary descriptors.

UNIT – V **8 Hrs**

Image Segmentation: Introduction, Detection of isolated points, Line detection, Edge detection, Edge linking, Region based segmentation – Region growing, Split and merge technique, Local processing, Regional processing, Hough transform, Segmentation using Threshold.

Choice: Unit-I and Unit-II

Text Books:

1. "Digital Image Processing", Rafael C G., Woods R E. and Eddins S L, Prentice Hall, 3rd Edition, 2008.

Reference Books:

1. "Image Processing, Analysis and Machine Vision", Milan Sonka, Thomson Press India Ltd., 4th Edition.
2. "Fundamentals of Digital Image Processing", Anil K. Jain, 2nd Edition, Prentice Hall of India.
3. "Digital Image Processing", S. Sridhar, Oxford University Press, 2nd Edition, 2016.

E Books:

1. `https://bookboon.com/en/digital-image-processing-part-one-ebook`
2. `https://pakuni.info/download/digital-image-processing-by-jayaraman-pdf-book-free-download/`

MOOCs:

1. `https://www.coursera.org/learn/digital`
2. `https://www.classcentral.com/course/swayam-digital-image-processing-14005`

NOTE: This course content can be supplemented by practical experimentation in a simulator environment for clear understanding.

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Course Title	**ROBOTICS**				
Course Code	**19EC5PE2RB**	**Credits**	**3**	**L – T – P**	**3:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: Knowledge of basic statics and dynamics, Basic programming using C/C++, Linear Algebra.

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply knowledge of Mechanics, Electrical Sciences and Computation to understand Robotic Systems and Components	1	–
CO2	Analyze concepts used in Robotic systems.	2	–
CO3	Design Robotic Systems meeting the specifications for a particular application	3	–
CO4	Demonstrate practice of Robotics either by performing experiments or by presenting a proposal for building simple Robotic applications	4	–

UNIT – I **8 Hrs**

Introduction to Robotics: History, Robots, Robot Usage, Industrial Robots and Their Applications: Robot Subsystems, Classification of Robots, Industrial Applications – Actuators and Grippers: Electric Actuators, Hydraulic Actuators, Pneumatic Actuators, Selection of Motors, Grippers, Sensors, Vision and Signal Conditioning: Sensor Classification, Internal Sensors, External Sensors, Vision, Signal Conditioning, Sensor Selection.

UNIT – II **9 Hrs**

Transformations & Kinematics: Robot Architecture, Pose of a Rigid Body, Coordinate Transformation, Denavit and Hartenberg (DH) Parameters, A Variant of DH Parameters, DH Parametrization of Euler angles. Forward Position Analysis, Inverse Position Analysis, Velocity Analysis: The Jacobian Matrix, Link Velocities, Jacobian Computation, Jacobian using the Decoupled Natural Orthogonal Complement (DeNOC), Forward and Inverse Velocity Analyses, Acceleration Analysis.

UNIT – III **8 Hrs**

Dynamics: Inertia Properties, Euler-Lagrange Formulation, Newton-Euler Formulation, Recursive Newton-Euler Algorithm, Dynamic Algorithms.

UNIT – IV **7 Hrs**

Linear Control: Control Techniques, Dynamic Systems, Transfer Function and State-Space Representation, A Robotic Joint Performance and Stability of Feedback Control, Proportional-Derivative-Integral (PID) Control of a Moving Block, Selection of PID Controller Gains, State-feedback Control Joint Controllers.

UNIT – V **7 Hrs**

Nonlinear, Force Controls and Motion Planning: Nonlinear and Force Controls, Control of a Moving Block, Multivariable Robot Control, Joint Space Planning, Cartesian Space Planning, Path Primitives, Cartesian Trajectories, Point-to-Point vs. Continuous Path Planning.

Choice: Unit-I and Unit-II

Text Books:

1. "Introduction to Robotics", S. K. Saha, McGraw Hill Education (India) Private Limited, 2nd Edition, 2014.
2. "Robotics: Mechanics and Control", K. R. Guruprasad, PHI Learning Private Limited, 2019.

Reference Books:

1. "Introduction to Robotics: Mechanics and Control", John Craig, Pearson Education Inc, 3rd Edition, 2009.
2. "Introduction to Robotics: Analysis Systems and Applications", Saeed B. Nikku, PHI Learning Private Limited, New Delhi, 2001.

E Books:

1. `http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.703.5185&rep=rep1&type=pdf`

MOOCs:

1. `https://www.my-mooc.com/en/categorie/robotics`

NOTE: The course will touch upon practical aspects and students are encouraged to execute a project such as on Robotics vehicle, Surveillance Robot, Pick-n-Play Robot etc.

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Course Title	OPERATING SYSTEM				
Course Code	19EC5PE2OS	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Understanding of Microprocessor / Microcontroller Architecture, Understanding of Memory and I/O system, Basic understanding of System Software.

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of different classes and structure of operating system and analyze the requirement of system security and protection	1	1, 2
CO2	Analyze process scheduling, synchronization and memory management functionality of operating system.	1, 2	1, 2
CO3	Analyze the device management and engage in writing device drivers for Linux/Windows system as a case study.	1, 2	1, 2

UNIT – I **8 Hrs**

Introduction and overview of Operating Systems: Computing environment and nature of computations, Operating System and its Operation, Classes of operating systems: Multi programming systems, Time sharing systems; Different Structures of an operating system, Virtual machine operating systems, Kernel based operating systems.

UNIT – II **8 Hrs**

Process management: Processes and threads: Processes and Program, implementing processes: Process States and State transitions, Process Context & Process control Block, Context Save, Scheduling & Dispatching, Threads, POSIX Threads, Case Study: Processes and Threads creation in Linux with Programming.

UNIT – III **8 Hrs**

Process Synchronization: Race conditions, Critical sections, Control Synchronization and

Indivisible operations, Semaphores, Implementation of Semaphore, Deadlock condition, Case Study: Process Synchronization.

Scheduling: Scheduling Concepts, Non-preemptive and Preemptive Scheduling Policies, Real Time Scheduling: EDF, RMS, Program Examples.

UNIT – IV **8 Hrs**

Memory management: Memory allocation to a process, Heap Management: Reuse of Memory, Contiguous memory allocation, Non-contiguous memory allocation, Paging, Segmentation, Virtual Memory concept, Demand Paging and Page Replacement examples.

UNIT – V **7 Hrs**

I/O Management: Interrupt handlers, Device drivers, Device independent I/O software, User space I/O software, Case Study: Device drivers for Linux/Windows.

Choice: Unit-I and Unit-II

Text Books:

1. "Operating Systems: A Concept based Approach", D. M. Dhamdhare, TMH.
2. "Modern Operating Systems", Andrew S. Tanenbaum, Herbert Boss, 4th Edition.

Reference Books:

1. "Operating Systems Concepts", Silberschatz and Galvin, John Wiley, 7th Edition, 2001.
2. "Operating System – Internals and Design Systems", William Stallings, Pearson Education, 4th Edition, 2006.

E Books:

1. `http://www.freebookcentre.net/ComputerScience-Books-Download/Operating-System-Concepts`

MOOCs:

1. `https://www.mooc-list.com/tags/operating-systems`
2. `https://www.mooc-list.com/course/operating-systems-saylororg`

NOTE: This course can have value addition with case study and programming using POSIX APIs for OS services.

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Course Title	**INNOVATION FOR ENTREPRENEURSHIP**				
Course Code	**19ES5HSIFE**	**Credits**	**2**	**L – T – P**	**2:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply new ideas of design thinking, methods and ways of thinking	2	–
CO2	Able to formulate goals as entrepreneur for a start-up defining your goals as an entrepreneur	3	–
CO3	Able to identify business opportunities by performing market research and choosing target customer	2	–
CO4	Engage with a range of stakeholders to deliver creative and sustainable solutions to specific problems communicate effectively both orally and in writing	7, 10	–
CO5	Work effectively with peers with diverse skills, experiences and be able to critically reflect on own practice	9	–

UNIT – I **6 Hrs**

Ideation and Innovation

Problems and Pain Points, Ideation and Problem Solving, Design Thinking, Team importance and Leadership, Market Segmentation, Beach-head Market, Building End User Profile, Total Addressable Market (TAM) Size for the Beachhead Market, Profile the Persona, Full Lifecycle Use Case, High-Level Product Specification, Quantify the Value Proposition, Identify Your Next 10 Customers, Define Your Core, Chart Your Competitive Position.

UNIT – II **5 Hrs**

Product Acquisition by customer

Determine the Customer's Decision Making Unit (DMU), Process to Acquire a Paying Customer, Mapping sale process, Total Addressable Market Size for Follow-on Markets.

UNIT – III **5 Hrs**

Business from Product

Design a Business Model, Set your Pricing Framework, Calculate the Lifetime Value (LTV) of an Acquired Customer, Map the Sales Process to Acquire a Customer, Calculate the Cost of Customer Acquisition (COCA).

UNIT – IV **4 Hrs**

Designing, building and scaling of the product

Identify key Assumptions, Test Key Assumptions, Define and build Minimum Viable Product (MVP), Test with Customer, Repeat Cycle to Reach Product Market Fit.

UNIT – V **6 Hrs**

Start-up and Entrepreneurship in India

Starting company in India, IP landscape, Incubation, Government support, Taxation, Startup culture and leadership, Open innovation, Social Innovation, Intrapreneurship, entrepreneurship abroad.

Reference Books:

1. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup", Bill Aulet, Wiley, 1st Edition, 2013. ISBN: 1118692284.
2. "The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company", Steve Blank and Bob Dorf, K&S Ranch Publishers, 2016.
3. "Innovator's Dilemma: When New Technologies Cause Great Firms to Fail", Christensen, Harvard Business Review Press, 2011.

E books:

1. https://segera-wisuda.blogspot.in/2016/05/46-ebooks-entrepreneurship-download-free.html

MOOCs:

1. https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring-2013/assignments/assignment-12/
2. https://www.edx.org/course/entrepreneurship-101-who-customer-mitx-15-390x

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Course Title	**MINI PROJECT II**				
Course Code	**19EC5PWMP2**	**Credits**	**2**	**L – T – P**	**0:0:2**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Enable the Students to formulate short research projects in a team under the direction of members of the faculty	1, 2, 4	1, 2
CO2	Undertake fabrication work of new experimental set up/devices or develop software packages	5	3
CO3	Extend or use the idea in mini project to take it up to the next level, by preparing detailed report describing the project and results	3, 6, 7	1, 2
CO4	Make effective communication by presentation of the work with professional ethics as an individual or a member of a team.	8, 9, 10, 11	2
CO5	Develop sustainable system with scope for enhancement and continue life-long learning.	12	–

VI Semester Syllabus

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Course Title	COMPUTER COMMUNICATION NETWORKS				
Course Code	19EC6PCCCN	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Fundamentals of Digital communication and Digital Signal Processing.

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the concepts of Computer Networks and Networks Models for Data Communication.	–	–
CO2	Apply the knowledge of networking and concepts of TCP/IP protocol stack to deliver packets across Multiple Networks (links).	1	1, 2
CO3	Analyze the issues of routing and congestion mechanism for independent and internetworking networks for wired and wireless link	2	1, 2
CO4	Design, calculate, and apply subnet masks and routing addresses to fulfil networking requirements.	3	1, 2
CO5	Create Network for given specification and conduct experiments within a simulated networking environment	4, 5, 9, 10	1, 2

UNIT – I **7 Hrs**

Introduction to Data Communication, Network Models, Digital Transmission, Bandwidth Utilization, Transmission Media, Wireless Transmission, Switching,Telephone and Cable TV for data transmission.

UNIT – II **7 Hrs**

Data Link Layer: Data link Control, Error detection and correction.

UNIT – III **8 Hrs**

Medium Access: Medium Access, Wired LANs: Ethernet, Wireless LANs. Connecting devices and Virtual LANS.

UNIT – IV **8 Hrs**

Network Layer: Logical Addressing, Internet Protocol, Address Mapping, Error Reporting, Delivery, Forwarding and Routing.

UNIT – V **9 Hrs**

Transport layer: Process to process Delivery, Congestion control and Quality of Service.

Choice: Unit-III and Unit-V

Text Books:

1. "Data Communication and Networking", B. Forouzan, 4th Edition, TMH, 2006.
2. "Computer Networks", Andrew S.Tanenbaum, 4th Edition, EEE.
3. "Computer Communication and Networks", J Frauzon.
4. "Data and computer communication", William Stallings, PHI.

Reference Books:

1. "Computer Networks", James F. Kurose and Keith W. Ross, Pearson education, 2nd Edition, 2003.
2. "Introduction to Data communication and Networking", Wayne Tomasi, Pearson education, 2007.
3. "An Engineering Approach on Computer Networking", S. Keshav, Addison Welsey.

E Books:

1. https://www.e-booksdirectory.com/details.php?ebook=10361
2. https://www.e-booksdirectory.com/details.php?ebook=7190

MOOCs:

1. http://nptel.ac.in/video.php?subjectId=106105081
2. http://freevideolectures.com/Course/2278/Data-Communication

LABORATORY EXPERIMENT LIST (using QualNet Simulator)

Sl. No.	Title of the Experiment
1.	Analysis and comparison of networks with different topologies
2.	Configuration and Analysis of Ethernet LAN
3.	Analysis and Determination the number of packets dropped in a point to point network
4.	Analysis of Multicast traffic and multicast protocol
5.	Comparison of Multicast and multiple unicast traffic
6.	Simulation and Analysis of wireless ad hoc network
7.	Model a network with two LAN connected by a switch and analysis of the sub-net
8.	Analysis of connecting devices, configuration of router used to connect 2 sub-nets
9.	Comparison and Analysis of routing algorithms(RIP and OSPF)
10.	Simulate and Analyze wireless infrastructure network
11.	Scrutiny of traffic between wired and wireless network
12.	Simulate and analyse working of wireless Ad hoc network with mobility given to the nodes

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Course Title	**MIXED SIGNAL DESIGN**				
Course Code	**19EC6PCMSD**	**Credits**	**4**	**L – T – P**	**3:0:1**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: Analog Electronic Circuits, Linear Integrated Circuits, Fundamentals of VLSI

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the knowledge of basic CMOS technology to analog integrated circuits	1	1, 3
CO2	Analyze CMOS based Analog, ADC and DAC circuits	2	1, 3
CO3	Design analog CMOS integrated circuits and mixed signal circuits	3	1, 3
CO4	Conduct experiments on Analog and mixed signal CMOS circuits using modern EDA tools	4, 5, 9, 10	1, 3

UNIT – I **8 Hrs**

Review of MOS Device Models, Single-Stage Amplifiers: Basic Concepts, Common-Source Stage, Source Follower, Common-Gate Stage, Cascode Stage.

UNIT – II **7 Hrs**

Differential Amplifiers: Basic Differential Pair: Qualitative Analysis, Quantative Analysis, Common-Mode Response, Differential Pair with MOS loads. Basic Current Mirrors, Cascode Current Mirrors.

UNIT – III **8 Hrs**

Active Current Mirrors: Large-Signal Analysis, Small-Signal Analysis, Common-Mode Properties. Operational Amplifiers: General Considerations, One-Stage Op Amps, Two-Stage Op Amps, Gain Boosting.

UNIT – IV **7 Hrs**

Switched-Capacitor Circuits: General Considerations, Sampling Switches, Switched-Capacitor Amplifiers, Switched-Capacitor Integrator, Switched-Capacitor Common-Mode Feedback.

UNIT – V **9 Hrs**

Digital-to-Analog Converter specifications: DNL, INL, Offset, Gain error, Latency, SNR, Dynamic Range.

Analog-to-Digital Converter specifications: Quantization error, DNL, INL, Missing codes, Offset, Gain error, Aliasing, SNR, Aperture error, Mixed-Signal layout issues.

DAC Architectures: R-2R ladder DAC, Current Steering DACs, Charge Scaling DACs, Pipeline DAC.

ADC Architectures: Pipeline ADC, Integrating ADCs, Successive Approximation ADC, Oversampling ADCs.

Choice: Unit-III and Unit-V

Text Books:

1. "Design of Analog CMOS Integrated Circuits", Behzad Razavi, McGraw Hill Edition, 2002, ISBN: 0-07-238032-2.
2. "CMOS Circuit Design, Layout and Simulation", R. Jacob Baker, 3rd Edition, IEEE Press, 2010, ISBN: 978-0-470-88132-3.

Reference Books:

1. "Analog Design Essentials", Willy M. C. Sansen, Springer, 2006. ISBN-10 0-387-25747-0.
2. "Analysis and Design of Analog Integrated Circuits", Gray, Hurst, Lewis and Meyer, 5th Edition, 2010, John Wiley & Sons.

E Books:

1. `http://www.designinganalogchips.com/_count/designinganalogchips.pdf`

MOOCs:

1. `https://nptel.ac.in/courses/117106030/`
2. `https://nptel.ac.in/courses/117106034/`

LABORATORY EXPERIMENT LIST

Sl. No.	Title of the Experiment
	Conduction using Cadence tools
1.	Draw the schematic of a CMOS inverter and obtain the DC characteristics. Also perform the transient analysis and determine the delay of the inverter.
2.	Common Source amplifier: Transient, DC and AC analysis
3.	Common Drain amplifier: Transient, DC and AC analysis
4.	Basic (fully) Differential amplifier: Transient, DC and AC analysis. Find the CMRR.
5.	Differential Input, Single-ended output operational amplifier: Transient, DC and AC analysis. Find the CMRR.
6.	OpAmp cascaded with Common-Source amplifier to form 2-stage OpAmp: Transient, DC and AC analysis
7.	Design R-2R ladder DAC using the OpAmp designed above and measure the DNL and INL of the DAC
8.	Draw the layout of CMOS inverter and verify DRC, LVS
9.	Draw the layout of Common Source amplifier and verify DRC, LVS.
10.	Draw the layout of Common Drain amplifier and verify DRC, LVS.
	Conduction using Verilog-AMS
11.	Modeling of Resistors, Capacitors, Ideal diode, Voltage & Current sources
12.	Modeling of SAR ADC

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Course Title	COMMUNICATION THEORY II				
Course Code	19EC6PCCT2	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Digital Signal Processing, Communication Theory I, MATLAB Programming

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of various signal processing and coding techniques for efficient and reliable digital communications	1	1
CO2	Analyze the performance of given digital communication techniques	2	1
CO3	Design the digital communication system for a given set of specification	3	1
CO4	Conduct hardware experiments and simulate experiments to demonstrate design and analysis of concepts	4, 5, 9, 10	1, 3

UNIT – I **9 Hrs**

Introduction to Digital Communication System (DCS), Block diagram of DCS with basic signal processing operations, Communication channel.

Pulse code modulation: Uniform quantization and its SQNR, Robust quantization – Companding, Differential PCM Transmitter and Receiver, Delta modulation and its SQNR, TDM-PCM, T1 and E1 digital Hierarchy. Line codes.

ISI in band limited channels: Zero-ISI condition – the Nyquist criterion, Solution for zero ISI – Practical raised cosine filters and Duo binary encoding and decoding.

UNIT – II **9 Hrs**

Optimum Receiver: Structures for AWGN channel – correlator type receivers, Matched filter type receivers, Properties, Power and Bandwidth efficiency.

Digital Modulations: Generation and detection of ASK, BPSK and BFSK, Signal space constellations, Probability of bit error computation for BPSK, Generation and detection of QPSK, Waveforms and its Signal space constellation, Probability of bit error expression, Generation and detection of DPSK, Waveforms, Probability of bit error expression, Performance analysis of all the schemes in terms of probability of bit error, Bandwidth and Power.

UNIT – III **7 Hrs**

Introduction to spread spectrum: Need for Spread Spectrum Modulation, PN sequence and its properties, Direct sequence SS system – DS/BPSK Transmitter & Receiver, Processing gain, Jamming margin, Frequency hop SS system- FH-FSK transmitter and Receiver, Fast and slow hop, Application of DSSS and FHSS for multiuser environment — CDMA, Multipath fading.

Introduction to OFDM: Concept, Comparison with FDM, Block diagram of OFDM.

UNIT – IV **7 Hrs**

Introduction to Information theory: Measurement of Information, Entropy and information rate, Communication channels, Shannon's Channel Capacity theorem and its trade off.

Source coding: Definition, Various Properties of Source Codes, Shannon-Fano encoding algorithm, Huffman's coding algorithm, efficiency and variance computation.

UNIT – V **7 Hrs**

Introduction to Channel coding: Need for channel coding, Shannon's coding theorem.

Linear Block codes: Rate, Encoding procedure, Error detecting and correcting capability, Syndrome calculation for error detection.

Convolutional Encoding: Convolutional encoder representation, Impulse response, Transform domain representation, Tree, Trellis and State representation.

Choice: Unit-I and Unit-II

Text Books:

1. "Digital Communications", Simon Haykins, John Wiley, 2003.
2. "Digital Communications", Bernard Sklar, Pearson Education, 2007.

Reference Books:

1. "Modern Digital and Analog Communication Systems", B. P. Lathi and Zhi Ding, Oxford University Press.
2. "Concepts of Information Theory and Coding", P. S. Satyanarayana, Dynaram, 2005.

E Books:

1. "Digital Communication", John R. Barry, Edward A. Lee, David G. Messerschmitt.

2. "Communication Systems", Simon Haykin, 4th Edition.

MOOCs:

1. NPTEL lecture series: Prof Bikas Kumar Dey, IIT Bombay.
2. NPTEL lecture series: Digital Communications, IIT Madras.

LIST OF LABORATORY EXPERIMENTS

PART A (Hardware Experiments)

1. Flat top sampling using Sample and hold circuit
2. Generation and detection of BASK for given specifications
3. Generation and detection of BFSK for given specifications
4. Generation and detection of BPSK for given specifications
5. Study and compute directivity/gain of antennas
6. Study of different modulations and demodulation on SDR platform

PART B (**Simulation Experiments** on MATLAB Platform)

1. Simulation of techniques learnt in Unit I – PCM, DPCM
2. Simulation of techniques learnt in Unit II – Different Modulations
3. Simulation of techniques learnt in Unit III – Spread spectrum
4. Simulation of techniques learnt in Unit IV – Source Coding
5. Simulation of techniques learnt in Unit V – Channel Coding
6. Simulation of end to end Communication system with BER plots (for AWGN channel)

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Course Title	AUTOMOTIVE EMBEDDED SYSTEMS				
Course Code	19EC6PE3AE	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites:

- Understanding of sensor principles
- Knowledge on control systems
- Knowledge of modeling tool such as Simulink

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of sensors, control theory, instrumentation and AUTOSAR to develop embedded automotive subsystems.	1	3
CO2	Analyze model based design approach in realizing automotive subsystems.	2	3
CO3	Design automotive subsystems for specified applications using model based and/or conventional approach.	3	3

UNIT – I **7 Hrs**

Automotive Architecture: Need for Electronics in Automotive, Introduction to ECUs, Vehicle Functional Domains and their requirements – General Context, Functional Domains, Standardized Components, Models, and Processes, Intelligent Vehicle Technologies – Road Transport and Its Evolution, New Technologies, Dependability Issues, Fully autonomous car.

UNIT – II **8 Hrs**

The systems approach to control and instrumentation: Concept of a system, Block diagram representation of a system, Electronic system performance, Instruments, Basic Measurement System, Signal Processing, Control Systems: P, PI, PID controllers. Model Based Design approach: Definition, Driving force for MBD, Benefits of MBD, Contextual requirements of MBD, MBD technology.

UNIT – III **8 Hrs**

Case studies of MBD (Block diagram approach only), Electronics engine Control: Motivation for electronic engine control, Concept of electronic engine control system, Electronic fuel control system: Configuration and Control sequence, Electronic ignition, Automatic Cruise Control, Antilock Braking System (ABS), Electronic Suspension System, Electronic Steering Control.

UNIT – IV **8 Hrs**

Sensors: Air flow rate sensor, Engine crankshaft angular position sensor, Magnetic reluctance position sensor, Engine speed sensor, Hall-effect sensor, Throttle angle sensor, Typical coolant sensor, Exhaust gas oxygen sensor.

UNIT – V **8 Hrs**

A Review of Embedded Automotive Protocols: Different Networks for Different Requirements, Event-Triggered versus Time-Triggered, LIN, CAN, MOST, FlexRay, Middle-ware Layer: Rationale for a Middle-ware, Main Objectives of AUTOSAR, Layered Software Architecture, BSW and RTE, Virtual function bus, AUTOSAR in Practice: Demonstration of AUTOSAR-Compliant ECUs.

Choice: Unit-III and Unit-V

Text Books:

1. "Automotive Embedded Systems Handbook", Nicolas Navet, Industrial Information Technology Series, CRC press.
2. "Understanding Automotive Electronics", William B. Ribbens, Elsevier.

Reference Books:

1. "Automotive Software Architecture", Miroslaw Staron, Sringer, 2017.

E Books:

1. https://dl.acm.org/doi/book/10.5555/2414762

MOOCs:

1. https://www.mooc-list.com/tags/automotive-systems

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Course Title	SYSTEM VERILOG & VERIFICATION				
Course Code	19EC6PE3SV	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Digital Design Fundamentals, ASIC Design Flow, HDL Programming

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the principles of verification, OOPs concepts in System Verilog, layered test bench architecture and its components	–	–
CO2	Apply the knowledge of system Verilog to build basic verification environment	1	3
CO3	Analyze a given design and come up with suitable test cases to achieve 100% coverage	2	3

UNIT – I **6 Hrs**

Verification Concepts: Concepts of Verification, Importance of verification, Stimulus vs Verification, Functional verification, Test bench generation, Functional verification approaches, Typical verification flow, Stimulus generation, Direct testing, Coverage: Code and Functional coverage, Coverage plan.

UNIT – II **9 Hrs**

System Verilog – 1: System Verilog constructs – Data types: Two-state data, Four-state data, Strings, Arrays: Queues, Dynamic and Associative Arrays, Enumerated types. Program blocks, Module, Interfaces, Clocking blocks, Modports.

UNIT – III **9 Hrs**

System Verilog – 2: SV Classes: Language evolution, Classes and objects, Class Variables and Methods, Class instantiation, Inheritance and encapsulation, Polymorphism. Randomization: Directed Vs Random Testing. Randomization: Constraint Driven Randomization, Virtual Interfaces.

UNIT – IV **6 Hrs**

Assertions: Introduction to Assertion based verification, Immediate and concurrent assertions.

UNIT – V **9 Hrs**

Coverage Driven Verification: Motivation, Types of coverage, Cover Group, Cover Point, Cross Coverage, Concepts of Binning and event sampling. Layered testbench architecture.

Choice: Unit-III and Unit-V

Text Books:

1. "SystemVerilog for Verification: A Guide to Learning the Testbench Language Features", Chris Spear, 2nd Edition, Springer.

Reference Books:

1. "Writing Testbenches Using System Verilog", Janick Bergeron.
2. "Verification Methodology Manual for System Verilog", Janick Bergeron, Eduard Cerny, Alan Hunter and Andy Nightingale.

E Books:

1. "SystemVerilog for Verification: A Guide to Learning the Testbench Language Features", Chris Spear.

Websites:

1. `www.asic-world.com`
2. `www.testbench.in`
3. `http://www.vlsi-expert.com/2011/03/static-timing-analysis-sta-basic-timing.html`

Online Materials: Seer Academy recordings
MOOCs:

1. `http://verificationexcellence.in/online-courses/`

NOTE: The Course will be supplemented by hands-on lab sessions using Cadence EDA tools.

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Course Title	DATA STRUCTURES & APPLICATIONS				
Course Code	19EC6PE3DS	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: C/C++ Programming

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand various methods of realizing data structures. Apply appropriate programming concepts to realize various data structures	1	1, 2
CO2	Analyze the suitability of a given data structure for a given application	2	1, 2
CO3	Develop time and memory efficient data structure/s for given application/s	3, 5, 10	1, 2

UNIT – I **07 Hrs**

Introduction: Revision of OOP concepts – Templates, operator overloading, inheritance, Data Representation methods, Linear lists, Formula-based representation and linked representation, Analysis of different representation methods, Exercises on list manipulation.

UNIT – II **10 Hrs**

Arrays and Matrices: Arrays, Overloading operators to add features, Realize 1D, 2D, . . . , nD arrays, Inherit classes to add features to existing basic classes Importance of mapping functions, Visualizing n-D matrices, Realization of matrices, perform matrix operations, Special matrices: Diagonal, triangular, tridiagonal, sparse matrices and their importance, Space and time implication of realizing special matrices.

UNIT – III **10 Hrs**

Stacks and Queues (linear and circular): The abstract data type, Formula-based representation, Linked representation, Applications: Parenthesis match, Tower of Hanoi, Machine shop scheduling (conversion and evaluation of prefix and postfix expressions).

UNIT – IV **06 Hrs**

Binary Trees: Representation methods, Properties, Tree operations, Binary tree traversal methods and algorithms, Expression trees. Binary search trees (BST): Concept of dictionary, BST: Representation, Insertion and Deletion.

UNIT – V **06 Hrs**

Heaps: Min and Max heaps – Representation, Insertion and Deletion, Heap sort, Machine scheduling, Huffman codes, AVL trees: Representation, Insertion and Deletion (All concepts through algorithms).

Choice: Unit-II and Unit-III

Text Books:

1. "Data structures, Algorithms and Applications in C++", Sartaj Sahni, McGraw Hill, 2000.
2. "Data structures and Algorithm Analysis in C++", Mark Allan Weiss, Pearson, 2013.

Reference Books:

1. "Data Structures Using C and C++", Y. Langsam, M. Augenstein and A. M. Tenenbaum, Prentice Hall Of India Pvt. Ltd., 2nd Edition, 2006.

E Books:

1. "Scilab Textbook Companion for Data Structures Using C And C++ by Y. Langsam, M. Augenstein and A. M. Tenenbaum", Created by Dharmesh Majethiya NIT Tiruchirappalli, 2013.

MOOCs:

1. Data Structures and Algorithms `https://nptel.ac.in/courses/106/102/106102064/`
2. Programming data structures and Algorithms `https://nptel.ac.in/courses/106/106/106106133/`

NOTE: Header files and exception handlers will be developed as part of course. Also, applications will be developed as services using modular approach to enrich the learning.

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Course Title	INTERNET OF THINGS				
Course Code	19EC6PE3IT	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites:

- Knowledge of microprocessor and controller hardware
- Knowledge of C, C++ and Python (can pick up during the course)
- Networking concepts and technologies

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of IoT Architecture, Network, Hardware and Software structures for real-world applications	1	1, 2
CO2	Analyze elements of IoT: Smart Objects, Access technologies, Layered Protocols and Data Analytics	2	1, 2
CO3	Design of Smart IoT applications that provide solutions for sustainable development	6, 10	1, 2
CO4	Use open-source platform for deployment of Smart Objects and demonstrate applications for given specifications	10	1, 2

UNIT – I **7 Hrs**

What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, IoT Challenges, IoT Network Architecture and Design.

UNIT – II **8 Hrs**

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

UNIT – III **8 Hrs**

IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

UNIT – IV **8 Hrs**

Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, Formal Risk Analysis Structures: OCTAVE and FAIR.

UNIT – V **8 Hrs**

IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, ArduinoUNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints – RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture. Smart City Security Architecture, Smart City Use-Case Examples.

Choice: Unit-III and Unit-IV

Text Books:

1. "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things", David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton and Jerome Henry, 1st Edition, Pearson Education (Cisco Press Indian Reprint), ISBN: 978-9386873743.
2. "Internet of Things", Srinivasa K. G., CENGAGE Leaning India, 2017.

Reference Books:

1. "Internet of Things: A Hands-on Approach", Vijay Madisetti and Arshdeep Bahga, 1st Edition, VPT, 2014, ISBN: 978-8173719547.
2. "Internet of Things: Architecture and Design Principles", Raj Kamal, 1st Edition, McGraw Hill Education, 2017, ISBN: 978-9352605224.

Online Resources:

1. `https://www.youtube.com/watch?v=co2MLqkJVXs`
2. `https://www.youtube.com/watch?v=9znRbMTimvc`

E Books:

1. http://alvarestech.com/temp/Industry4.0/2019/Dimitrios%20Serpanos,Marilyn%20Wolf%20(auth.)%20-%20%20Internet-ofThings%20(IoT)%20Systems_%20Architectures,%20Algorithms,%20Methodologies-Springer%20International%20Publishing%20(2018).pdf
2. https://www.oreilly.com/design/free/files/designing-for-the-internet-of-things.pdf

MOOCs:

1. https://nptel.ac.in/courses/106/105/106105166/
2. https://www.coursera.org/specializations/internet-of-things

NOTE: The course will be supplemented by project based learning.

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Course Title	MACHINE LEARNING				
Course Code	19EC6CE1ML	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites:

- Knowledge of Linear Algebra
- Knowledge of Calculus
- Knowledge of Probability and Statistics
- Basic knowledge of Programming

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of mathematics and programming to structure datasets and algorithms to build machine learning models	1	2
CO2	Analyze dataset features for different use cases and performance measures to evaluate the models	2	2
CO3	Design and develop application models using supervised and unsupervised machine learning algorithms	3	2

UNIT – I **9 Hrs**

Python for ML: Data types, Understanding and creation of: Lists, Tuples, Dictionaries, Writing functions, Conditional and looping statements, Python libraries for ML: Data Preparation using Numpy and Pandas functions, Parsing and Importing data from a text file, Data Visualization with Matplotlib.

Introduction: Machine Learning (ML) Landscape, Why use ML, Types of ML systems: Supervised, Unsupervised, Semi-supervised and Reinforcement learning, Challenges of ML, Problems ML can solve, Classification and Regression Overview.

UNIT – II **9 Hrs**

Classification: kNN algorithm – k-Nearest Neighbours classification algorithm flow and

concepts, Testing the classifier, Improving the classification performance with kNN (handwriting recognition system), Evaluation Metrices: MAE, MSE, RMSE, RAE, RSE, R2-score.

Decision trees: Construction of decision trees, Information gain and entropy, confusion matrix, Precision, Recall and F1score, Dataset splitting based on a feature, Matplotlib annotations to visualize a tree, Concept of ensembling: Bagging and Boosting, Random Forest.

UNIT – III **7 Hrs**

Classifying with probability theory: Naive Bayes and Logistic Regression Algorithms, Training and testing the classifier model, Performance measures: Log loss, Jaccard Index & Accuracy score.

UNIT – IV **7 Hrs**

Regression: Simple & Multiple Linear regression for continuous value prediction, Training & Testing the regression model, Cross validation and performance evaluation, Evaluating Classification Vs Regression for any dataset.

UNIT – V **7 Hrs**

Unsupervised Learning: Types of Unsupervised Learning, Challenges in Unsupervised Learning, Pre-processing and Scaling, Applying Data Transformation, K-Means Clustering, Euclidean distance, Manhattan distance and Minkowski distance. Case Study: Recommender system. Introduction to Artificial Neural Networks and Deep Learning.

Choice: Unit-II and Unit-IV

Text Books:

1. "Introduction to Machine Learning", Ethem Alpaydin, PHI Learning, 3rd Edition 2015.
2. "Introduction to Machine Learning with Python: A Guide for Data Scientists", Andreas C. Muller and Sarah Guido, O'Reilly Publication, 2019.

Reference Books:

1. "Machine Learning", Tom M. Mitchell, McGraw-Hill, 1st Edition, 2013.
2. "Machine Learning in Action", Peter Harrington, Dreamtech Press Indian Edition, 2017.

E Books:

1. https://www.pdfdrive.com/machine-learning-with-python-cookbook-practical-solutions-from-preprocessing-to-deep-learning-d176361144.html

MOOCs:

1. https://www.simplilearn.com/artificial-intelligence-masters-program-training-course

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	ADVANCED MICROCONTROLLER AND APPLICATIONS				
Course Code	19EC6CE1AM	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites:

- Basic knowledge of 8-bit microcontroller architecture
- Basic programming skill in assembly and C
- Knowledge on working with IDEs

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the acquired knowledge on ARM7 and ARM Cortex M3 architecture, their features and instruction set in-programming the ARM processor	1	1, 2
CO2	Analyze the architectural features of ARM7 and Cortex M3,concepts on system software and communication protocol stack design ARM based embedded applications	2	1, 2
CO3	Design and develop ARM based embedded applications	3, 5, 9, 10	2

UNIT – I **8 Hrs**

Migration from 8-bit to 32-bit cores, RISC design and ARM Design Approach, ARM7 TDMI core Dataflow model, Pipeline, Cortex M3 Processor & its applications, Cortex M3 Architecture and Registers, Operation Modes, Nested Vector Interrupt Controller, Debug Support.

UNIT – II **8 Hrs**

Thumb2 Technology: Instruction Set Architecture & programming, Exceptions & Interrupts, Stack memory, Memory Map, Bit banding.

UNIT – III **8 Hrs**

Cortex M3 Programming: A typical development flow, Using C, CMSIS, Using Assembly, Interrupt behavior, Exception Programming.

UNIT – IV **8 Hrs**

Introduction to Firmware, Boot-loader and Embedded Operating Systems, MMU & Virtual Address Translation, Cache Memory and address mapping.

UNIT – V **7 Hrs**

ARM SoC: Working with UART, I2C, SPI & USB Protocols.

Building Applications with ARM Cortex M3: Robotics & Motion Control, WSN, IoT.

Choice: Unit-II and Unit-III

Text Books:

1. "The Definitive Guide to ARM Cortex M3", Joseph Yiu, 2nd Edition.
2. "ARM System Developer's Guide", Andrew N. Sloss, Dominic Symes and Chris Wright.

Reference Books:

1. "ARM System-On-Chip Architecture", Steve Furber, Addison Wesley, Pearson Education, 2nd Edition.
2. "ARM Architectural Reference Manual", Jagger (Ed), Prentice Hall.

E Books:

1. `https://community.arm.com/developer/ip-products/system/f/embedded-forum/2227/ebooks-for-arm`

MOOCs:

1. `https://www.edx.org/course/embedded-systems-shape-the-world-microcontroller-i`

NOTE: This course will be value added with projects based learning. Any cross compiler can be used for running CotrexM3 based assembly programs and developing embedded applications.

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**COMPUTER VISION**				
Course Code	**19EC6CE1CV**	**Credits**	**3**	**L – T – P**	**3:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: NIL

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply various segmentation, feature extraction and representation techniques for a give pattern analysis problem.	1	1, 3
CO2	Analyze various pattern recognition and classification schemes to perform a specific computer vision task	2	1, 3
CO3	Design 3D visualization models to process a 3D object for a specific computer vision task	3	1, 3

UNIT – I **7 Hrs**

Pattern Analysis: Clustering: K-Means, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN-models.

UNIT – II **9 Hrs**

Feature extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners – Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH.

UNIT – III **7 Hrs**

Shape representation and segmentation: Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors.

UNIT – IV **9 Hrs**

3D Image Visualization: Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

UNIT – V **7 Hrs**

Modern Trends: Biometrics – Fingerprint, Face, Iris, Digital signature; Super resolution, Introduction to Augmented Reality.

Choice: Unit-II and Unit-IV

Text Books:

1. "Computer Vision: Algorithms and Applications", Richard Szeliski, Springer-Verlag (London) Limited, 2011.
2. "Computer Vision: A Modern Approach", D. A. Forsyth and J. Ponce, Pearson Education, 2003.

Reference Books:

1. "Multiple View Geometry in Computer Vision", Richard Hartley and Andrew Zisserman, 2nd Edition, Cambridge University Press, March 2004.
2. "Introduction to Statistical Pattern Recognition", K. Fukunaga, 2nd Edition, Academic Press, Morgan Kaufmann, 1990.
3. "Digital Image Processing", R. C. Gonzalez and R. E. Woods, Addison-Wesley, 1992.

E Books:

1. `http://freecomputerbooks.com/Programming-Computer-Vision-with-Python.html`
2. `http://freecomputerbooks.com/Computer-Vision-Algorithms-and-Applications.htm`

MOOCs:

1. `https://www.coursera.org/learn/computer-vision-basics`
2. `https://www.edx.org/course/computer-vision-and-image-analysis`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	PHYSICAL DESIGN				
Course Code	19EC6CE1PD	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic understanding of Register-Transfer-Level (RTL) Design and Synthesis in ASIC Flow

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the advanced concepts of modern VLSI system design including standard cells, cell libraries, IPs etc.	–	3
CO2	Apply the knowledge of backend physical design flow, including Floor-planning, Placement, Clock Tree Synthesis and Routing	1	3
CO3	Analyze the timing reports and fix timing violations in the back end	2	3

UNIT – I **8 Hrs**

Physical design flow: Libraries and File Formats. Introduction to physical design automation, Physical Design flow, EDA tools, Input files, Libraries: Standard Cells, Transistor Sizing, Input-Output Pads, Library Characterization, Constraints based design, File formats: Library Exchange Format (LEF), Design Exchange Format (DEF), Liberty Timing File (LIB), ESD and its sources, Library characterization, Timing models: Delay model, NLDM, Polynomial Delay model, Current source model.

UNIT – II **8 Hrs**

Partitioning and Floor planning: Partitioning Techniques, Classification of Partitioning Algorithms, Floor planning, Design Style Specific Issues, macro placement, Floor planning Algorithms.

UNIT – III **8 Hrs**

Placement: Design Style Specific Placement Problems, Goals of placement and Sanity

checks before placement. Classification of Placement algorithms, Simulation Based Placement Algorithms: Simulated Annealing, Force Directed Placement, Interconnection Topologies, Estimation of Wire length.

UNIT – IV **7 Hrs**

Clock Tree Synthesis and Timing Analysis: Sanity checks before CTS. Need and goals of CTS. CTS related Terminologies. Clock skew reduction techniques and Topologies.Clock buffering mechanism. Post CTS Optimization. Basic timing related quantities.

UNIT – V **8 Hrs**

Routing and signoff checks: Goals of Routing, Routing Prerequisites, Routing Constraints, Global Routing, Track Assignment, Detail Routing, Routing algorithms. Design Rule Check (DRC), Layout versus Schematic (LVS), Commonly faced LVS issues, IR Drop Analysis: Static IR drop analysis, Dynamic IR drop analysis, Methods to reduce IR drop: Electromigration (EM), Methods to fix EM.

Choice: Unit-I and Unit-V

Text Books:

1. "Physical Design Essentials: An ASIC Design Implementation Perspective", Khosrow Golshan, Springer Science+Business Media, 2007.
2. "Algorithms for VLSI Physical Design Automation", Naveed A. Sherwani, Springer.

Reference Books:

1. "An Introduction to VLSI Physical Design", Majid Sarrafzadeh and C. K. Wong, McGraw Hill International Edition 1995.
2. "Physical Design and Automation of VLSI systems", Preas M. Lorenzatti, The Benjamin Cummins Publishers, 1998.

E Books:

1. "Algorithms for VLSI Physical Design Automation", Naveed A. Sherwani, Springer.

MOOCs:

1. `https://www.digimat.in/nptel/courses/video/106105161/L01.html`

NOTE: The Course will be supplemented by hands-on lab sessions using Cadence/ Synopsis EDA tools.

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**ELECTRONIC ENGINEERING MATERIALS**				
Course Code	**19EC6OE1EM**	**Credits**	**3**	**L – T – P**	**3:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: NIL

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply concepts of physics and chemistry to identify the application of materials in various engineering domains	1	1
CO2	Analyze the various material preparation and characterization techniques available and hence infer on the selection of a method to suit requirements	2	1
CO3	Conduct survey on recent application of materials and write a report/survey paper while following professional ethics	4, 9, 10, 12	3

UNIT – I **7 Hrs**

Introduction: Classification of engineering materials, Levels of structure, Structure-property relationships in materials, Units, Constants and Conversion factors, Basic Thermodynamic Functions, Statistical nature of Entropy, Kinetics of thermally activated processes, Novel materials for sensing applications.

UNIT – II **9 Hrs**

Electrical properties of materials: Electrical conduction, Conductivity, Conduction in terms of band and atomic bonding models, Electron mobility, Electrical resistivity of metals, Electrical characteristics of commercial alloys, Semi-conductivity, Temperature dependence of carrier concentration, Factors that affect carrier mobility, Hall effect, Dielectric behaviour, Types of polarization, Frequency dependence of the dielectric constant, Ferro electricity, Piezoelectricity.

UNIT – III **7 Hrs**

Optical properties: Basic concepts, Absorption process, Tauc relation to calculate band gap of materials, Refractive index. Applications of optical properties: photoconductivity, fluorescence and luminescence.

UNIT – IV **9 Hrs**

Fabrication methods: Thermal Evaporation, e-beam evaporation, Sputtering, Spin coating, CVD techniques.

UNIT – V **7 Hrs**

Characterization of materials: XRD, SEM, AFM, TEM, Van der Pauw method of resistance measurement

Choice: Unit-II and Unit-V

Text Books:

1. "Elementary Solid State Physics: Principles and Applications", Omar Ali, 6th Edition, Pearson.
2. "Material Science and Engineering: A First Course", V. Raghavan, 6th Edition, PHI.
3. "Material Science and Engineering", William D. Callister, 2nd Edition, Wiley.

Reference Books:

1. "Materials Science of Thin Films", Milton Ohring, 2nd Edition, Academic Press.

E Books:

1. https://pdfs.semanticscholar.org/fac1/91c1fa2e11ff2dd5367c02b88e65fda25011.pdf
2. https://shodhganga.inflibnet.ac.in/bitstream/10603/60701/8/08_chapter%202.pdf

MOOCs:

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/112/105/112105053/

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	ENGINEERING ECONOMICS				
Course Code	19EC6HSEEC	Credits	2	L – T – P	2:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Acquire the skills to apply the basics of economics in engineering field	1	–
CO2	Perform cost analysis for optimization to engineering products	2	–
CO3	Take economically sound decisions in maintenance of products	3	–

UNIT – I **5 Hrs**

Introduction to Economics: Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – P/V ratio.

UNIT – II **5 Hrs**

Elementary Economic Analysis: Introduction – Material selection for product, Design selection for a product, Material design – Process planning.

UNIT – III **6 Hrs**

Value Engineering: Interest formulae and their applications – Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor – equal payment series capital recovery factor – Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT – IV **5 Hrs**

Cash Flow: Revenue dominated cash flow diagram, Cost dominated cash flow diagram,

Annual equivalent method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), Rate of return method, Examples in all the methods.

UNIT – V **5 Hrs**

Replacement and Maintenance Analysis:

Maintenance: Types of maintenance, Types of replacement problem, Determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return.

Depreciation: Introduction, Straight line method of depreciation, Declining balance method of depreciation, Sum of the years digits method of depreciation, Sinking fund method of depreciation/ Annuity method of depreciation, Service output method of depreciation.

Choice: Unit-IV and Unit-V

Text Books:

1. "Engineering Economics", R. Panneerselvam, Prentice Hall of India Ltd, New Delhi, 2001.

Reference Books:

1. "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. "Engineering Economics and Analysis", Donald G. Newman and Jerome P. Lavelle, Engineering Press, Texas, 2010.
3. "Engineering Economy", Degarmo, E.P., Sullivan, W.G and Canada, J.R, Macmillan, New York, 2011.
4. "Engineering Economy", Zahid A. Khan, Dorling Kindersley.

E Books:

1. `https://easyengineering.net/engineering-economics-by-panneerselvam-book/`

MOOCs:

1. `https://www.coursera.org/lecture/faecalsludge/4-7-engineering-economics-KoVa9`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**TECHNICAL SEMINAR ON SAFETY & STANDARDS / SUSTAINABILITY & ENVIRONMENT / ENGINEERING & TECHNOLOGY FOR SOCIETY**				
Course Code	**19EC6SRTSR**	**Credits**	**2**	**L – T – P**	**0:0:2**
CIE	**50 Marks (100% weightage)**		**SEE**	**50 Marks (100% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the impact of Electronics and Communication Engineering solutions in societal and environmental context	7, 9, 10, 12	1, 2, 3
CO2	Demonstrate the professional knowledge to propose solutions for sustainable development.	6, 7, 8, 9, 10, 12	1, 2, 3

VII Semester Syllabus

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	BIOLOGY FOR ENGINEERS				
Course Code	19ES7BSBFE	Credits	2	L – T – P	2:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: NIL

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand and explain basic concepts of Biology, role of Biology in organic farming	7	–
CO2	Apply the knowledge of Biology to convey the role of basic building blocks of life	1, 6	–
CO3	Understand the basics of radiation and its effects on Human Body	6, 9, 10	–
CO4	Technical documentation and presentation of case study on impact of emerging technologies on Biological sciences	7, 9, 10	–

UNIT – I **5 Hrs**

Introduction: Why Engineers Should Study Biology?, What Is life?, The Hierarchy of Life, Evolution, Taxonomy, Interaction of Living Things with the Environment, Brief History of Life, Basic Organic Chemical Structure.

UNIT – II **5 Hrs**

Composition of Living Things: Carbohydrates, Lipids, Proteins, Nucleic Acids, Hybrid and Other Compounds.

The Cell: The Common Denominator of Living Things, Prokaryotes and Eukaryotes, The Biological Membrane, Eukaryotic Cell Structure and Function, Cell Reproduction.

UNIT – III **5 Hrs**

Introduction to Radiation: Where does Radiation Come from, Types of Radiation, Types

of Ionizing Radiation, X-rays for Medical Use and Generators, Types of Electromagnetic Waves, Ionization of Radiation – Property of Ionizing Radiation, Types of Radiation and Biological Effects, Penetrating Power of Radiation, Penetrating Power of Radiation within the Body, Penetrating Power and Range of Effects on the Human Body.

UNIT – IV **6 Hrs**

Radiation Effects on Human Body: Types of Effects, Exposure Modes and Effects, Classification of Radiation Effects, Deterministic Effects and Stochastic Effects. Mechanism of Causing Effects on Human Body: Ionization due to Radiation, Damage and Repair of DNA, DNA $\rightarrow$ Cells $\rightarrow$ Human Body, Radiation Damage to DNA, Lapse of Time after Exposure and Effects, Deterministic Effects, Radiosensitivity of Organs and Tissues, Stochastic Effects.

Cell phone Radiation Hazards: Introduction, Mutation.

UNIT – V **5 Hrs**

Organic Farming: History and Background, Requirements of Plants for Soil-Derived Nutrients: Effects of Nitrogen, Phosphorous and Potassium on Plant Growth and Quality, Symptoms of Nitrogen, Phosphorous and Potassium Deficiency in Crops.

Choice: Unit-II and Unit-V

Text Books:

1. "Biology for Engineers", Arthur T. Johnson, 2nd Edition, CRC Press, 2019.
2. "Environmental Biology for Engineers and Scientists", David A. Vaccari, Peter F. Strom and James E. Alleman, Wiley Interscience, 2006.
3. "Science and Technology of Organic Farming", Allen V. Barker, CRC Press, 2010.

Reference Books:

1. "Biology for Engineers and Non-Biologists", Suraishkumar and Madhulika Dixit, IIT Madras, Oxford University Press.
2. "Electromagnetic Radiation Due to Cellular, Wi-Fi and Bluetooth Technologies: How Safe are we?", Naren, Anubhav Elhence, Vinay Chamola, Mohsen Guizani, IEEE Access, vol. 8, pp. 42980-43000, 2020.
3. "India's Organic Farming Revolution", Sapna E. Thottathil, University of Iowa Press, Iowa City, 2014

MOOCs:

1. `https://nptel.ac.in/courses/121/106/121106008/`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	EMBEDDED SYSTEM DESIGN				
Course Code	19EC7PCESD	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites:

- Knowledge of microcontroller hardware features
- Microcontroller basic programming using C/C++
- Overall knowledge of computer architecture

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the functioning and features of processors, memory and I/O systems in developing embedded system.	1	1, 2
CO2	Analyze the embedded OS functionality and device drivers used in multitasking embedded applications	2	1, 2
CO3	Design embedded applications using given specifications and concepts of communication protocols and modules	3	1, 2
CO4	Demonstrate practical experiments on developing embedded systems	4, 5	1, 2

UNIT – I **8 Hrs**

Introduction to Embedded System: Architecture, Computing Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface: Analog & Digital, Timers, Embedded Firmware, Quality Attributes of Embedded Systems.

UNIT – II **8 Hrs**

Embedded I/O & Memory: Different approaches of I/O operation: Polling, Interrupt, DMA, Interrupt & DMA Controllers, Memory controller, Communication Protocols features & functioning: I2C, SPI, USB, Ethernet, Wi-Fi, Bluetooth.

UNIT – III **8 Hrs**

Embedded Firmware Development: Embedded Firmware Design Approaches, Programming in Embedded C: Examples with GPIO, PWM, ADC, UART, I2C, SPI.

UNIT – IV **8 Hrs**

Real-Time Operating System (RTOS) based Embedded System Design: Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Task Communication, Task Synchronization, Writing Device Drivers, How to Choose an RTOS.

UNIT – V **7 Hrs**

The Embedded System Development Environment: The Integrated Development Environment (IDE), Types of Files Generated on Cross-compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging.

Choice: Unit-II and Unit-III

Text Books:

1. "Introduction to Embedded Systems", Shibu K. V., Tata McGraw Hill Education Private Limited, 2009.
2. "Embedded System Design: A Unified Hardware/Software Introduction", Frank Vahid and Tony Givargis, Wiley Publication, 2006.

Reference Books:

1. "Embedded Systems – A contemporary Design Tool", James K. Peckol, John Wiley, 2008.
2. "Computer Organization & Embedded System", Carl Hamacher and Naraig Manjikian, McGraw Hill Publication, 2014.

E Books:

1. https://electrovolt.ir/wp-content/uploads/2018/04/Programming-with-Stm32-Getting-Started-with-the-Nucleo.pdf
2. http://www.multimedialab.be/doc/erg/2018-2019/Raspberry_Pi/Raspberry_Pi_The_Complete_Manual_8th_Ed_2016.pdf

MOOCs:

1. https://www.mooc-list.com/tags/embedded-systems
2. https://www.edx.org/course/embedded-systems-shape-the-world-microcontroller-i

LABORATORY EXPERIMENT LIST

Sl. No.	Title of the Experiment
	Conduction using Hardware
1.	UART programming to display message on Hyper Terminal using LPC 1768
2.	PWM Programming with interrupt to control DCM speed
3.	Programming external interrupt through interrupt controller
4.	Read/Write data through SPI controller using interrupt
5.	Read analog input at ADC port and display the converted digital data on LCD
6.	Program to interface the IR sensor to Raspberry Pi and verify the result
7.	Program to interface the DHT sensor to Raspberry Pi and verify the result
8.	Socket programming on R-Pi to establish server-client communication

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(Autonomous College under VTU)

Course Title	RF & MICROWAVE ENGINEERING				
Course Code	19EC7PCRFM	Credits	2	L – T – P	2:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Knowledge of Network Analysis and Analog Communication

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Define, understand and explain the significance of microwaves and microwave transmission line	6, 7	2
CO2	Apply the knowledge of S-parameter terminology to describe microwave circuits and multiPort network	1	1
CO3	Analyze the characteristics of microwave circuits comprising hollow, dielectric and planar waveguides, transmission lines, passive components and active devices; and compute required parameters.	2	1

UNIT – I **6 Hrs**

Radio Frequency (RF) Waves: RF Spectrum Bands, RF Circuit Design Considerations: Low RF and High RF circuits, RF Electronics Concepts: RF versus DC or Low AC signals, RF Impedance Matching.

Transmission line at RF: Transmission line equations, Characteristic and Input Impedances, Reflection and Transmission coefficients, Standing waves and SWR, Mismatch losses in Transmission Lines, Smith chart, Application of Smith chart.

UNIT – II **5 Hrs**

Microwave network theory: Scattering Matrix – Significance, Formulation and Properties, Symmetrical Z and Y parameters for reciprocal Networks, S matrix representation of multi-port networks, S-parameters of a two-port network with mismatched load (Quantitative Analysis).

UNIT – III **6 Hrs**

Waveguide Components-I: Waveguide multi-port junctions – E plane and H plane Tees, Magic Tee, 2-hole Directional coupler, Waveguide discontinuities – Waveguide Windows, Tuning screws and posts, Irises, Transitions, Twists, Bends, Corners and matched loads (Quantitative Analysis).

Waveguide Components-II: Ferrites composition and characteristics, Faraday rotation, Ferrite components – Isolator, Circulator (Qualitative analysis only).

UNIT – IV **5 Hrs**

Active Devices: Schottky diode, PIN diode, Transfer electron devices – GUNN diodes.

Avalanche transit time devices: IMPATT Diodes, TRAPATT Diodes, BARITT Diodes, Parametric amplifiers (Qualitative analysis Only).

UNIT – V **4 Hrs**

Modern Trends in Microwaves Engineering: Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference / Electromagnetic Compatibility (EMI / EMC), Monolithic Microwave IC fabrication, RF-MEMS for microwave components, Microwave Imaging

Choice: Unit-I and Unit-III

Text Books:

1. "Radio Frequency and Microwave Electronics", Matthew M. Radmanesh, Pearson, 2015.
2. "Microwave Engineering", Annapurna Das, Sisir K. Das, TMH Publication, 2001.
3. "Microwave Devices and Circuits", Samuel Y. Liao, 3rd Edition, Pearson/PHI.

Reference Books:

1. "Microwave Engineering", David M. Pozar, John Wiley, 2nd Edition, 2004.
2. "Microwave Engineering: Passive Circuits", Peter A. Rizzi, Prentice-Hall.
3. "RF Microelectronics", Behzad Razavi, Pearson Education, 2008.

E Books:

1. "RF and Microwave Engineering: Fundamentals of Wireless Communications", Frank Gustrau.
2. "Handbook of RF and Microwave Power Amplifiers", J. Walker.

MOOCs:

1. https://nptel.ac.in/courses/108/101/108101112/#
2. https://onlinecourses.nptel.ac.in/noc20_ee04/

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	WIRELESS COMMUNICATION				
Course Code	19EC7CE2WC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Knowledge of Analog and Digital Communication

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Acquire the knowledge of Architecture, Techniques and algorithms in Wireless Communication systems	–	–
CO2	Apply the knowledge of traffic Engineering, radio wave propagation, receiver characteristics to predict the traffic and coverage of various cellular networks	1	1
CO3	Analyze the resource allocation strategies, propagation models, diversity techniques, Call flow scenarios applied to various mobile communication networks	2	1
CO4	Use modern tools to analyse a given problem statement in wireless communication	4	1

UNIT – I **8 Hrs**

Introduction to Wireless communication, The Cellular concept: System design fundamentals: Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and Grade of service, Improving coverage and capacity in cellular system.

UNIT – II **8 Hrs**

Mobile radio propagation: Introduction to Radio wave propagation, free-space propagation model, three Basic Propagation mechanism, Propagation models: Okumura Hata, Cost-Hata, Walfisch-Ikegami, Log distance Path loss model, Practical Link budget calculation, Small-scale multipath propagation, Impulse response model of a multipath channel, small scale multipath measurements, Parameters of mobile multipath channels.

UNIT – III **7 Hrs**

Equalization and Diversity: Fundamentals of Equalization, Training a generic adaptive equalizer, Equalizers in communication receiver, Linear Equalizer and Nonlinear Equalization, Algorithms for Adaptive Equalization, Diversity techniques, Space Diversity, Time Diversity, Polarization Diversity, Frequency Diversity (Qualitative Analysis only).

UNIT – IV **8 Hrs**

Global System for Mobile communication (2G): System overview – GSM Architecture, GSM MS block description, The air interface, Logical and physical channels, Frame structure, GSM Spectrum (900 MHz and 1800 MHz), Call establishment scenarios, GPRS/EDGE architecture, UMTS (3G) Architecture, UMTS Technical features.

UNIT – V **8 Hrs**

Introduction to Long Term Evolution (4G): LTE Architecture, Radio Spectrum, Frame Structure, OFDMA Principle, OFDMA Transmitter, OFDMA Receiver, Physical channels, Signal flow during Cell Search, UL Transmission, DL transmission.

Choice: Unit-III and Unit-IV

Text Books:

1. "Wireless Communication Principles and Practice", Theodore S. Rappaport, Pearson, September 2010.
2. "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications", Christopher Cox, Wiley, March 2012.

Reference Books:

1. "Wireless Communication", Andreas F. Molish, Wiley, Student 2nd Edition.

E Books:

1. https://www.amazon.in/Wireless-Communications-Principles-Practice-2e/dp/8131731863
2. https://www.amazon.in/Introduction-LTE-LTE-Advanced-Mobile-Communications-ebook/dp/B00KBRNO32

MOOCs:

1. "Wireles communication for everybody", https://www.coursera.org/learn/wireless-communications
2. "Introduction to Wireless and Cellular Communications", Prof. R. David Koilpillai, IIT Madras. https://swayam.gov.in/nd1_noc20_ee61/preview
3. "Wireless Communications", Dr. Ranjan Bose, Department of Electrical Engineering, IIT Delhi. (NPTEL lectures)

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	NETWORK SECURITY & CRYPTOGRAPHY				
Course Code	19EC7CE2NC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Knowledge of Computer Communication Networks

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of encryption and security techniques along with cyber forensics to fulfil the societal needs	1	2
CO2	Analyse the different types of encipherment techniques along with key exchange mechanisms	2	2
CO3	Submit a report and give a presentation on the impact/growth of network Security tools for societal and sustained development	9, 10	–

UNIT – I **7 Hrs**

Introduction, Services, mechanisms and attacks, The OSI security Architecture, A model for network security, A model for network security, Symmetric Ciphers: Symmetric Cipher model, Symmetric Ciphers: Symmetric Cipher model, Substitution techniques Transposition technique.

UNIT – II **9 Hrs**

Simplified DES, Simplified DES, Data encryption Standard, mode of Block cipher operation, Principles of public key cryptosystems, Principles of public key cryptosystems, The RSA algorithm, Diffe-Hellman key exchange, Authentication functions, Digital Signatures, Digital Signature standard.

UNIT – III **9 Hrs**

Electronic Mail Security: Pretty Good Privacy, web security: Web Security Consideration, Secure Electronic Transaction, Intruders, Intruder detection, Password management, Viruses and related threats, Viruses and related threats, Firewalls design principles.

UNIT – IV **7 Hrs**

Incident Response and Forensic Analysis:Incident Response Plans: Incident Detection, Incident Response and Containment, Recovery and resumption, Review and improvement. Forensics: Legal Requirements, Evidence Acquisition, Evidence Analysis.

UNIT – V **7 Hrs**

Practical Implementations of Cryptography/Security:Cryptographic solutions using Java: Framework, JCA, JCE. Cryptographic solutions using Microsoft.NET framework: Class Model, Programmer's View.

Choice: Unit-II and Unit-III

Text Books:

1. "Cryptography and Network Security: Principles and Practice", William Stallings, 3rd Edition.
2. "The Complete Reference Network Security", Roberta Bragg, Mark Rhodes-Ousley and Keith Strassberg.
3. "Cryptography and Network Security", Atul Kahate, 3rd Edition, McGraw Hill.

Reference Books:

1. "Cryptography and Network Security", Behrouz A. Forouzan, TMH, 2007.
2. "Fundamentals of Network Security", Eric Maiwald, McGraw Hill, 2009.
3. "Network Security – Private Communication in a Public World", Charlie Kaufman, Radia Perlman and Mike Speciner, 2nd Edition, Prentice Hall.

E Books:

1. https://www.e-booksdirectory.com/details.php?ebook=10710
2. https://www.e-booksdirectory.com/details.php?ebook=7010

MOOCs:

1. https://nptel.ac.in/courses/106/105/106105031/
2. https://swayam.gov.in/nd1_noc20_cs21/
3. http://www.nptelvideos.in/2012/11/cryptography-and-network-security.html

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	SYSTEM ON CHIP				
Course Code	19EC7CE2SC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites:

- Basics of SoC design and system architecture
- Concepts of interconnect architecture and bus architecture of SoC
- Principles of memory design and cache architecture
- Basic knowledge of ASIC design flow and FPGA design flow

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the System on Chip design, Architecture and complexity in designing	–	3
CO2	Apply the design concepts for Processors and interconnect architecture	1	3
CO3	Analyze and design solutions for issues at system level, and issues of Hardware-Software co-design	2, 3	3

UNIT – I **8 Hrs**

Introduction to Systems Approach: System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

UNIT – II **8 Hrs**

Processors: Introduction, Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling.

Buffers: Minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors, Processor Evolution with examples.

UNIT – III **8 Hrs**

System On Chip Design Process: A canonical SoC Design, SoC Design flow, waterfall vs spiral, top down vs bottom up, Specification requirement, Types of Specification, System Design Process, System level design issues, Soft IP vs Hard IP, IP verification and Integration. (Text 2).

UNIT – IV **7 Hrs**

Hardware-Software Co-design: Design for timing closure, Logic design issues, Verification strategy, On chip buses and interfaces, Low Power, Hardware Accelerators in SoC. (Text 2).

UNIT – V **8 Hrs**

Interconnect architectures for SoC: Bus architecture, SoC Standard buses, Analytic bus models, Beyond the bus: Network on Chip (NoC) with switch interconnects, NoC examples, Layered Architecture and NIU, Evaluating Interconnect Networks (Chapter 5, Text 1).

Choice: Unit-I and Unit-II

Text Books:

1. "Computer System Design System-on-Chip", Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd.
2. "Reuse Methodology Manual for System on Chip designs", Michael Keating and Pierre Bricaud, Kluwer Academic Publishers, 2nd Edition, 2008.

Reference Books:

1. "On-Chip Communication Architectures: System on Chip Interconnect", Sudeep Pasricha and Nikil Dutt, Morgan Kaufmann Publishers, 2008.
2. "Introduction to System-on-Package (SOP): Miniaturization of the Entire System", Rao R. Tummala and Madhavan Swaminathan, McGraw-Hill, 2008.

Web Resources:

1. https://www.ee.ryerson.ca/~courses/coe838/lecture-notes.html
2. https://www.xilinx.com/products/silicon-devices/soc/zynq-7000.html
3. https://www.altera.com/products/soc/overview/soc-resourceguide/Introduction.html
4. https://developer.arm.com/products/processors/cortex-a/cortex-a9

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	ELECTRONICS PACKAGING				
Course Code	19EC7CE2EP	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of semiconductors for Microelectronics system packaging	1	3
CO2	Design the mathematical equations and tools needed for calculating packaging design parameters	3	3

UNIT – I **7 Hrs**

Introduction to Microsystems Packaging: Microsystems, Microsystem Technologies, Microsystems Packaging (MSP), Importance of Microsystems Packaging, System-Level Microsystems Technologies, Expectation of a microsystem engineer, summary and future trends, Inventions of Microsystems and Packaging Technologies.

UNIT – II **9 Hrs**

Role of Packaging in Microelectronics: Microelectronics, Characteristics of Semiconductors, Microelectronic Devices, Integrated Circuits, IC Packaging, Semiconductor Roadmap, IC Packaging Challenges.

Role of Packaging in Microsystems: Electronic Product, Anatomy of a Microsystem, Computers and the Internet, Role of Packaging in the Computer Industry, Telecommunication Industry, Automotive Systems, Medical Electronics, Consumer Electronics and Micro-Electro-Mechanical Systems (MEMS) Products.

UNIT – III **7 Hrs**

Electrical package design: Fundamentals, Electrical anatomy of systems packaging, Signal distribution, Power distribution, Electromagnetic interference, Design process.

UNIT – IV **9 Hrs**

Single chip packaging: Functions of single chip packaging, Types, Fundamentals, Materials, Processes, Properties and characteristics of single chip packages. Summary and future trends.

Multichip packaging: Functionality, Advantages, Modules at system level, Types of multichip module substrates, Multichip module design, Multichip module Technology comparisons, Alternatives, Summary and future trends.

UNIT – V **7 Hrs**

Fundamentals of IC Assembly: Purpose, Requirements of IC assembly, IC Assembly technologies, Wire bonding, Tape Automated bonding.

Choice: Unit-II and Unit-IV

Text Books:

1. "Fundamentals of Device and Systems Packaging: Technologies and Applications", Rao R. Tummala, 2nd Edition, McGraw Hill Education.
2. "Introduction to System-on-Package (SOP): Miniaturization of the Entire System", Rao R. Tummala and Madhavan Swaminathan, 1st Edition, McGraw Hill Education.

Reference Books:

1. "Advanced Electronic Packaging", William D. Brown, IEEE Press, 1999.

E Books:

1. "An Overview of Advanced Electronic Packaging Technology", Hocheol Kwak and Todd H. Hubing, Technical report (2007).
2. D. Appello, P. Bernardi, M. Grosso and M. S. Reorda, "System-in-package testing: problems and solutions," in *IEEE Design & Test of Computers*, vol. 23, no. 3, pp. 203-211, May-June 2006, doi: 10.1109/MDT.2006.79.

MOOCs:

1. `https://nptel.ac.in/courses/108/108/108108031/`

NOTE: Students from electronics, electrical, mechanical and instrumentation background can register for the course. Course is based on process technology centric in the fields of semiconductor and chip packaging.

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	LOW POWER VLSI				
Course Code	19EC7CE2LV	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Fundamentals of VLSI

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the concept of power analysis at different levels of design abstraction	1	3
CO2	Analyze power dissipation using mathematical and probabilistic approach in digital logic cells	2	3
CO3	Design circuits for low power logic cells	3	3

UNIT – I **8 Hrs**

CMOS Fabrication Steps, Latch-up and its Prevention, Short-Channel Effects, Emerging Technologies for Low Power, MOS Inverter Configurations, Inverter Ratio in Different Configurations, Switching Characteristics, Delay Parameters, Driving Large Capacitance Loads.

UNIT – II **8 Hrs**

MOS Combinational Circuits: Pass-Transistor Logic, Gate Logic, MOS Dynamic Circuits. Sources of Power dissipation: Dynamic Power Dissipation, Short-Circuit Power Dissipation, Switching Power Dissipation, Glitching Power Dissipation, Leakage Power Dissipation.

UNIT – III **7 Hrs**

Supply Voltage Scaling for Low Power: Device feature size scaling, Architectural-Level Approaches, Multilevel Voltage Scaling and Challenges, Dynamic Voltage and Frequency Scaling, Adaptive Voltage Scaling, Sub-threshold Logic Circuits.

UNIT – IV **8 Hrs**

Switched Capacitance Minimization: Bus encoding, Clock Gating, Gated-Clock FSMs, Glitching Power Minimization, Logic Styles for Low Power. Leakage Power minimization Approaches: Fabrication of Multiple Threshold Voltages, VTCMOS Approach, Transistor Stacking, MTCMOS Approach, Power Gating Controller, Power Management, Dual-Vt assignment approach (DTCMOS), Dynamic V_{th} scaling.

UNIT – V **8 Hrs**

Adiabatic Logic Circuits: Adiabatic Charging, Amplification, Logic Gates, Pulsed Power Supply, Stepwise Charging Circuits. Battery-Aware Systems: Battery-Driven System Design, Energy-Aware Routing, Low-Power Software Approaches: Machine-Independent Software Optimizations.

Choice: Unit-IV and Unit-V

Text Books:

1. "Low-Power VLSI Circuits and Systems", Ajit Pal, Springer, 2015. ISBN 978-81-322-1936-1.

Reference Books:

1. "Low Power Digital CMOS Design", Anantha P. Chandrakasan and Robert W. Brodersen, Kluwer Academic Publishers, 1995.
2. "Low-Power CMOS VLSI Circuit Design", Koushik Roy and Sharat C. Prasad, John Wiley & Sons Inc., 2000.

E Books:

1. `http://leda.elfak.ni.ac.rs/education/projektovanjeVLSI/predavanja/10%20Low%20Power%20Design%20in%20VLSI.pdf`

MOOCs:

1. `https://nptel.ac.in/courses/106/105/106105034/`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**DEEP LEARNING**				
Course Code	**19EC7CE2DL**	**Credits**	**3**	**L – T – P**	**3:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites:

- Knowledge of Linear Algebra
- Knowledge of Calculus
- Knowledge of Probability and Statistics
- Basic knowledge of Programming.

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Apply the knowledge of mathematics and programming to structure datasets and algorithms to build deep learning models	1	2
CO2	Analyze various activation functions and optimization techniques to feed forward and back propagate in model training	2	2
CO3	Design and develop application models using deep neural networks, feature engineering and cross validation techniques.	3, 5, 8, 9, 10	2

UNIT – I **7 Hrs**

Introduction: A review of Machine Learning, Introduction to Deep Learning, The Math Behind Machine Learning: Linear Algebra, Statistics, Machine Learning Principles: Regression, classification, Clustering, Optimization, Model fitting and evaluation. Introduction to Python Libraries, TensorFlow, Keras.

UNIT – II **9 Hrs**

Neural Networks: The Biological Neuron, Perceptron, Multilayer Perceptron, Feed-Forward Networks with Sigmoid Activation, Backpropagation Learning with SGD, Activation Functions: Linear, Sigmoid, Tanh, Softmax, ReLu; Loss Functions for Regression and Classification.

UNIT – III **7 Hrs**

Optimization Algorithms, Hyper-parameters: Learning Rate, Regularization, Momentum, Sparsity, Fully Connected Neural Network, Model Training and Evaluation, Use case and Model Building.

UNIT – IV **9 Hrs**

Architectures of Deep Networks: Convolutional Neural Network, Architecture Overview: Input layers, Convolutional Layers, Pooling Layers, Fully connected layers, Applications of CNN, Variants of CNN Architecture, Model building using CNN on complex image data.

UNIT – V **7 Hrs**

Recurrent Neural Network Architecture, LSTM Networks, Building Blocks: Restricted Bolzman Machines(RBMs), Autoencoders, Variational Autoencoders, Applications of RNN & LSTM, Use cases and Model building.

Choice: Unit-II and Unit-IV

Text Books:

1. "Deep Learning – A Practitioner's Approach", Josh Patterson and Adam Gibson, O'Reilly Publication, 2019.
2. "Deep Learning with Python", Francois Chollet, Manning Publications, 1st Edition.

Reference Books:

1. "Python Data Science Handbook: Essential Tools for Working with Data", Jake VanderPlas, O'Reilly Publication, 2016-17.

E Books:

1. `https://www.pdfdrive.com/machine-learning-with-python-cookbook-practical-solutions-from-preprocessing-to-deep-learning-d176361144.html`

MOOCs:

1. `https://www.simplilearn.com/artificial-intelligence-masters-program-training-course`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	FUNDAMENTALS OF MOBILE COMMUNICATIONS				
Course Code	19EC7OE2MC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Acquire the knowledge of mobile communications fundamentals and standards and apply in solving traffic problems	1	1
CO2	Investigate m-commerce life cycle, financial services, entertainment services, content development and distribution and caching, through literature survey and use cases	4	1

UNIT – I **7 Hrs**

Introduction to mobile communication, spectrum allocation, services and range of operation. Evolution of Mobile communication from 2G to 4G, WLAN, Bluetooth,Multiple Access Technologies: FDMA, TDMA, CDMA, Organizational structure in mobile industry.

UNIT – II **8 Hrs**

Cellular Concepts, Frequency reuse, Channel assignment strategies, Call establishment, Handoff mechanism, Trunking concepts, Capacity expansion methods.

UNIT – III **8 Hrs**

GSM architecture, Frequency allocation, Channels in GSM, Frame structure, Handoff mechanisms, Power control mechanism, Call establishment and Security mechanism.

UNIT – IV **8 Hrs**

EDGE architecture, UMTS architecture, LTE Architecture, Wireless LAN (Wi-Fi), Mobile IP architecture, Emerging Wireless systems: Adhoc Wireless networks, Sensor networks, Distributed control network, Ultra-Wideband Systems (UWB).

UNIT – V **8 Hrs**

M-commece framework, Different players, Lifecycle, Different Mobile commerce applications and services, Content development and Distribution, Technologies, Standard bodies.

Choice: Unit-III and Unit-IV

Text Books:

1. "Wireless Communications: Principle and Practice", Theodore S. Rappaport, Prentice Hall, 2005 .
2. "Mobile Commerce: Technology, Theory and Applications", Brian Mennecke and Troy J. Strader, Idea Group Publishing.

Reference Books:

1. "Wireless Communication", Andreas F. Molish, Wiley, 2nd Edition.

E Books:

1. https://www.amazon.in/Wireless-Communications-Principles-Practice-2e/dp/8131731863
2. https://www.amazon.com/Mobile-Commerce-Technology-Theory-Applications/dp/1591400449

MOOCs:

1. Wireles communication for everybody: https://www.coursera.org/learn/wireless-communications
2. Introduction to Wireless and Cellular Communications by Prof. R. David Koilpillai, IIT Madras: https://swayam.gov.in/nd1_noc20_ee61/preview

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	PROJECT MANAGEMENT AND FINANCE				
Course Code	19ES7HSPMF	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Personality Development Course, Soft-skills

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of project management principles and to study the current market trends	1	1, 2, 3
CO2	Implement project management methodologies ethically for successful project completion	2, 8, 9	1, 2, 3
CO3	Identify the investment opportunities and to formulate the projects	11	1, 2, 3
CO4	Choose projects which benefit the society and organization and apply project phases and document them for future reference	6, 10, 12	1, 2, 3

UNIT – I **7 Hrs**

Concepts of Project Management: Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects.

Concepts of project, Categories of project, Project life cycle phases, Project management concepts, Tools and techniques for project management, The project manager, Basic education for a project manager, Roles and responsibilities of project manager, Project manager as profession, Summary.

UNIT – II **8 Hrs**

Establishing the Project: Scope, Time, Cost and performance goals, Feasibility report, Financing Arrangements, Preparation of cost estimates, Finalization of project implementation schedule, Evaluation of the project profitability, Appointing a project manager, Fixing the Zero date, Summary.

UNIT – III **8 Hrs**

Organizing Human Resources and Contracting: Delegation, Project managers authority, Project organization, Accountability in Project Execution, Contracts, R's of contracting, Tendering and Selection of Contractors, Team building, Summary.

UNIT – IV **8 Hrs**

Organizing Systems and Procedures for Project Implementation: Working of systems, Design of Systems, Project work system design, Work breakdown structure, Project execution plan, Project procedure manual, Project control system, Planning, Scheduling and Monitoring, Monitoring contracts, Project diary, Summary.

UNIT – V **8 Hrs**

Financing of Projects: Capital structure, Menu of financing, Internal accruals, Equity capital, Preference capital, Debentures (or bonds), Methods of offering term loans, Working capital advances, Miscellaneous sources, Raising venture capital, Project financing structures, Financial closure, Financial institutions, Summary.

Choice: Unit-III and Unit-IV

Text Books:

1. "Project Management", S. Choudary, Tata McGraw Hill.
2. "Projects – Planning, Analysis, Selection, Financing, Implementation and Review", Dr. Prasanna Chandra, McGraw Hill.
3. "Project Management Institute: A Guide to the Project Management Body of Knowledge (PMBOK) Guide", 6th Edition, Sept 2017.

Reference Books:

1. "Fundamentals of Project Management", Dr.Vijay Kanabar.
2. "Project Management", David I. Cleland, McGraw Hill International Edition.
3. "Project Management", Gopalakrishnan, McMillan India Ltd.
4. "Project Management", Harry and Maylor, Peason Publication.

E books and online course materials:

1. `http://swarm.cs.pub.ro/~mbarbulescu/SMPA/CMOS-VLSI-design.pdf`

MOOCs:

1. `https://www.youtube.com/watch?v=5d16JwWwjKo`
2. NPTEL lecture on Introduction to Project Management by Prof. Arun Kanda: `https://www.youtube.com/watch?v=5pwc2DYlKQU`

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	**MINI PROJECT III**				
Course Code	**19EC7PWMP3**	**Credits**	**2**	**L – T – P**	**0:0:2**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Ability to apply knowledge to identify, gather information and analyse to formulate the problem definition for project through detailed investigation.	1, 2, 4	1, 2
CO2	Ability to use appropriate tool/tools to implement and demonstrate the defined project.	5	3
CO3	Ability to design and develop sustainable solution/system for the betterment of the society.	3, 6, 7	1, 2
CO4	Ability to make effective presentation of the work with professional ethics as an individual or a member of a team.	8, 9, 10, 11	2
CO5	Ability to develop sustainable system with scope for enhancement and continue life-long learning.	12	–

VIII Semester Syllabus

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	INTELLECTUAL PROPERTY RIGHTS AND CYBER LAW				
Course Code	19ES8HSIPL	Credits	2	L – T – P	2:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand and commit to professional ethics and responsibilities to obtain Intellectual property Rights like Patents, Copyright and Trademarks	8	–
CO2	Understand the impact of Patents, Copyright and Trademarks and demonstrate the knowledge of Cyber Law for the societal and environmental context	7	–
CO3	Use IPRs and Cyber Law to access societal, health, safety and cultural issues	6	–
CO4	Work in multiple teams to effectively communicate IP and Cyber Law	9, 10	–

UNIT – I **5 Hrs**

Basic principles of IP laws & Patents: Introduction, Concept of property, Constitutional aspects of IP, Evolution of the patent system in UK, US and India, Basis for protection, Origin and meaning of the term patent, Objective of a patent law, principles underlying the patent law in India, the legislative provisions regulating patents, Non–patentable inventions.

UNIT – II **6 Hrs**

Procedure for obtaining patent: Submission of application, Filing provisional and complete specification, Examination of the application, advertisement of the acceptance, opposition, Grant and sealing of patent, Term of the patent, Compulsory license.

Provisional and complete specification: Definition of Specification, Kinds of specification, provisional specification, complete specification, Claims, Conditions for amendment.

Rights conferred on a patentee: Patent rights, Exception and limitations, Duties of a Patentee.

Transfer of patent: Forms of transfer of Patent rights, Assignment, kinds of assignment, License, kinds of license, Rights conferred on a licensee, Transmission of patent by operation of law.

Infringement of patents: Construction of claims and infringement, Patents held to be infringed, Patents held to be not infringed.

Action for Infringement: Where a suit is to be instituted, procedure followed in the suit, Onus of establishment infringement, Defence by the defendant, The Relief's, Injunction, Damages or account of profits, Patent agents.

UNIT – III **6 Hrs**

Copy Right: Meaning and characteristics of copy right, Indian copy right law, Requirement of copy right, Illustrations copy right in literary work, Musical work, Artistic work, work of architecture, Cinematograph film, Sound recording.

Author and Ownership of copy right: Ownership of copy right, Contract of service, Contract for service, Rights conferred by copy right, Terms of copy right, License of copy right.

Infringement of copy right: Acts which constitute infringement, General principle, Direct and indirect evidence of copying, Acts not constituting infringements, Infringements in literary, Dramatic and Musical works, Remedies against infringement of copy right.

Trade Marks: Introduction, Statutory authorities, Procedure of registration of trademarks, Rights conferred by registration of trademarks, Licensing in trade mark, Infringement of trade mark and action against infringement.

UNIT – IV **5 Hrs**

Cyber Law: An introduction, Definition, Why cyber law in India, Evolving cyber law practices – for corporates, Privacy in Indian cyber space. Terrorism and Cyber Crime. Cyber theft and Indian telegraph act, Cyber Stalking.

UNIT – V **4 Hrs**

Indian Cyber law: Protecting Indian children online, Spam, Contempt in cyber space, Indian consumers and cyber space, E-courts of India.

Choice: Unit-II and Unit-III

Text Books:

1. "Basic Principles and Acquisition of Intellectual Property Rights", Dr. T. Ramakrishna, CIPRA, NSLIU-2005.
2. "Intellectual Property Law Handbook", Dr. B. L. Wadehhra, Universal Law Publishing Co. Ltd., 2002.

3. “Cyberlaw: The Indian perspective”, Pavan Duggal, 2009 Edition.

Reference Books:

1. “Ownership and Enforcement of Intellectual Property Rights”, Dr. T Ramakrishna, CIPRA,NSLIU-2005.
2. “Intellectual Property Law (Bare Act with short comments)”, Dr. T Ramakrishna, Universal Law Publishing Co. Ltd., 2007.
3. “The Trademarks Act 1999 (Bare Act with short comments)”, Dr. T Ramakrishna, Universal Law Publishing Co. Ltd., 2005.

MOOCs:

1. https://nptel.ac.in/courses/110/105/110105139/
2. https://nptel.ac.in/courses/109/106/109106137/

B.M.S. College of Engineering, Bengaluru – 19

(Autonomous College under VTU)

Course Title	MICROELECTROMECHANICAL SYSTEMS				
Course Code	19EC8OE3ME	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: NIL

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the sensing principles of microsystems for real time applications	–	–
CO2	Design the microstructure using various micromachining process and tailor the device structure as per the requirement	3	2
CO3	Analyse various MEMS devices using simulation tools	2	2

UNIT – I **7 Hrs**

Overview of MEMS & Microsystems: MEMS & Microsystems, Typical MEMS and Microsystem Products, Evolution of Microfabrication, Microsystems and Microelectronics, The Multidisciplinary nature of Microsystem Design and Manufacture, Microsystems and Miniaturization, Applications of Microsystems in the Automotive and other Industries.

UNIT – II **9 Hrs**

Working principles of Microsystems:

Micro sensors: Acoustic Wave, Biomedical and biosensors, Chemical, Optical, Pressure and Thermal Sensors.

Microactuation: Actuation using Thermal forces, Shape-Memory Alloys, Piezoelectric crystals & Electrostatic forces.

UNIT – III **7 Hrs**

MEMS with Microactuators: Microgrippers, Micromotors, Microvalves, Micropumps, Microaccelerometers, Microfluidics.

Materials for MEMS and Microsystems: Introduction, Substrates and wafers, Active Substrate materials, Silicon as a substrate material, Silicon compounds, Silicon piezoresistors, Gallium Arsenide, Quartz, Polymers for MEMS, Packaging materials.

UNIT – IV **9 Hrs**

Micromachining Technologies:

Thin Film Deposition: Evaporation, Sputtering, Chemical Vapor deposition, Epitaxial growth of Silicon, Thermal Oxidation for Silicon dioxide. Lithography.

Etching: Isotropic Etching, Anisotropic Etching, Etch Stops, Dry Etching, Silicon Micromachining, Advanced Process for Microfabrication.

UNIT – V **7 Hrs**

Integration and Packaging: Microsystems and Microelectronics, Objectives of packaging, Special Issues in packaging, Types of microsystem Packages, Packaging Technologies, Reliability and Key failure mechanisms.

Choice: Unit-II and Unit-IV

Text Books:

1. "MEMS and Micro systems: Design, Manufacture and Nano scale Engineering", Tai-Ran Hsu 2nd Edition, John Wiley & Sons.
2. "Micro and smart systems", G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, V. K. Aatre, 1st Edition, Wiley India.

Reference Books:

1. "An Introduction to Microelectromechanical Systems Engineering", Nadim Maluf and Kirt Williams, 2nd Edition, Artech House.

E Books:

1. https://www.comsol.co.in/video/how-set-up-run-simulation-comsol-multiphysics
2. http://1.droppdf.com/files/MC684/encyclopedia-of-materials-characterization.pdf
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-777j-design-and-fabrication-of-microelectromechanical-devices-spring-2007/lecture-notes/

MOOCs:

1. https://nptel.ac.in/courses/117/105/117105082/
2. https://nptel.ac.in/courses/108/108/108108113/

B.M.S. College of Engineering, Bengaluru – 19

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Course Title	AUTOMOTIVE ELECTRONICS				
Course Code	19EC8OE3AE	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of engineering and science to analyze the performance of Automotive Battery Systems, Electronic Engine Control, working of Sensors and Actuators	1	1
CO2	Analyze the Vehicle Level Electronic Control for Automotive Subsystems	2	1
CO3	Gain insight about building future automotive subsystems that contributes to the safety and health of the society using block diagram approach	6	1

UNIT – I **7 Hrs**

Automotive Fundamentals Overview: Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System.

UNIT – II **7 Hrs**

Automotive Batteries and Starting System: Different types of Batteries – principle, rating, testing, Maintenance and charging, Lithium-ion batteries, Starting system,Ignition switch, Neutral safety switch, Starter relay, Starter solenoid, Battery, Starter motor.

UNIT – III **7 Hrs**

Electronic Engine Control: Motivation for Electronic Engine Control, Concept of an Electronic Engine Control Engine parameters, variables, Engine Performance terms, Electronic Fuel Control System.

UNIT – IV **9 Hrs**

Automotive Sensors: Oxygen (O2/EGO) Sensors, Engine Crankshaft Angular Position (CKP) Sensor, Magnetic Reluctance Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor - Strain gauge, Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor, Throttle angle sensor.

Automotive Actuators: Fuel Metering Actuator, Fuel Injector, Ignition Actuator and EGR Actuator.

UNIT – V **9 Hrs**

Vehicle Motion Control: Electronic suspension system, Antilock Brake System (ABS), Electronic Steering Control.

Automotive Diagnostics: Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics.

Overview of Automotive Network Protocols: CAN, LIN, MOST and FlexRay.

Future Automotive Electronic Systems: Collision Avoidance Radar warning Systems, Low tire pressure warning system, Automatic Driving Control System.

Choice: Unit-IV and Unit-V

Text Books:

1. "Understanding Automotive Electronics", William B. Ribbens, 6th Edition, SAMS/ Elsevier Publishing.

Reference Books:

1. "Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive", Robert Bosch GmbH (Ed.), 5th Edition, John Wiley & Sons Inc., 2007.

E Books:

1. `http://www.engineering108.com/Data/Engineering/Automobile/Understanding-Automotive-Electronics.pdf`
2. `www.sciencedirect.com/science/book/9780750675994`
3. `https://warwick.ac.uk/fac/sci/wmg/business/automotive_batteries_101_wmg-apc.pdf`
4. `http://fmcet.in/AUTO/AT6502_uw.pdf`

MOOCs:

1. `https://nptel.ac.in/courses/107/106/107106088/`

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(Autonomous College under VTU)

Course Title	**MAJOR PROJECT WORK**				
Course Code	**19EC8PWMPW**	**Credits**	**9**	**L – T – P**	**0:0:9**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Course Outcomes:

At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Ability to apply domain knowledge for addressing engineering problems related to society	1	1, 2
CO2	Ability to formulate, review literature and analyse the problem definition.	2	3
CO3	Ability to design and develop sustainable solutions for the problem definition to meet the specified needs with consideration for public health and safety and sustainable development.	3, 6, 7	1, 2
CO4	Ability to use the research based knowledge and methods to analyse and interpret the data using modern engineering tools to provide valid conclusion.	4, 5	2
CO5	Ability to apply ethical principles and commit to the professional ethics when working as an individual or in a team and communicate effectively with engineering community and society.	8, 9, 10, 12	1, 3
CO6	Ability to manage the project and finance effectively.	11	2
CO7	Ability to recognize the need for and engage in independent and lifelong learning.	12	1

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Course Title	**SEMINAR ON INTERNSHIP**				
Course Code	**19EC8SRISR**	**Credits**	**2**	**L – T – P**	**0:0:2**
CIE	**50 Marks (100% weightage)**		**SEE**	**50 Marks (100% weightage)**	

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Develop awareness about current global and contemporary issues in engineering and technology	6, 12	1
CO2	Familiarize the skills needed to work in an industry/corporate environment	9	1
CO3	Comprehend and present a report on the work done	10	1

Guidelines on Internship

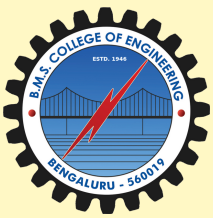
- Each student needs to complete a minimum of 12 weeks or 144 hours of Technical internship (1 week internship equated to 12 qualitative hours of participation).
- Each student needs to present a seminar on internship during the 8th semester. Internship will be evaluated for 2 credits, where the student needs to present the work done during internship. It can be presented as a consolidation of all the internship work carried out after the completion of 2nd semester onwards.

Note:

The internships can be taken up in an industry, a government organization, a research organization or an academic institution, either in the country or outside the country, that include activities like:

- Successful completion of Value Added Programs/Training Programs/ workshops organized by academic Institutions and Industries
- Soft skill training (maximum of 4 weeks only will be considered)
- Active association with incubation/ innovation /entrepreneurship cell of the institute

- Participation in Inter-Institute innovation related competitions like Hackathons
- Working for consultancy/ research project within the institutes
- Participation in activities of Institute's Innovation Council, IPR cell, Leadership Talks, Idea/ Design/ Innovation contests
- Internship with industry/ Government organizations/ Micro/ Small/ Medium enterprises
- Development of a prototype/product/business plan/start-up, any other related technical activity apart from Project work.



BMS COLLEGE OF ENGINEERING

P.O. BOX NO. 1908, BULL TEMPLE ROAD, BANGALORE - 560019
Phone: +91-080-2662 2130-35 Fax: +91 080 2661 4357
Website: www.bmsce.ac.in