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

2023-24 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 2023

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

PEO1 Graduates will Professionally Progress in Electronics, Communication and related areas with an inclination towards Continuous Learning

PEO2 Graduates will work in Diversified Teams of Multidisciplinary Environment

PEO3 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 in the Table 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

Curricular Component ↓ Sem →	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total Credits**
Basic Science Course (BS)	8	8	4	3					**23**
Engineering Science Course (ES)	9	9	3	3					**24**
Professional Core Course (PC)			14	14	14	11	6		**59**
Professional Elective Course (PE)					3	3	3	3	**12**
Open Elective Course (OE)						3	3	3	**09**
Project / Mini-Project (PW)					2	2	7		**11**
Internship (INT)								6	**06**
Humanities and Social Sciences, Management Course (HS)	1	1			3		1		**06**
Ability Enhancement Course (AE)/SDC	2	2	1	1		3			**09**
UHV Course				1					**01**
Non-Credit Mandatory Course	–	–	NC	NC	NC	NC	–	–	
Total Credits	**20**	**20**	**22**	**22**	**22**	**22**	**20**	**12**	**160**

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SCHEME

SEMESTER: III

Sl. No.	Course Type	Code	Course Title	Credits				Contact Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	BS	23MA3BSTFN	Transform Calculus, Fourier Series and Numerical Techniques	2	1	0	3	4	50	50	100
2	ES	23EC3ESHDL	HDL Programming	3	0	0	3	3	50	50	100
3	PC	23EC3PCAEC	Analog Electronic Circuits	3	0	0	3	3	50	50	100
4	PC	23EC3PCDCD	Digital Circuit Design	3	0	0	3	3	50	50	100
5	PC/IPCC	23EC3PCSAS	Signals and Systems	3	0	1	4	5	50	50	100
6	PC/IPCC	23ES3PCNAL	Network Analysis*	2	1	0	3	4	50	50	100
7	BS	23ES3BSBFE	Biology for Engineers**	1	0	0	1	1	50	50	100
8	PC/IPCC	23EC3PCIEL	Integrated Electronics Lab	0	0	1	1	2	50	50	100
9	AE/SDC	23EC3AEHPL	HDL Programming Lab	0	0	1	1	2	50	50	100
10	NCMC	YYNCMC3XX1	NCMC – 1	–	–	–	–	2	–	–	P/NP
			Total	**17**	**2**	**3**	**22**	**29**	**450**	**450**	**900**

***Common to EC, EE, EI, ET & MD** ****Common to EC, EE, EI & ET**

NCMC – 1:

Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
23NCMC3NS1	NSS – 1	23NCMC3YG1	Yoga – 1	23NCMC3PE1	Physical Education – 1
24NCMC3IM1	Indian Music – 1	24NCMC3ID1	Indian Dance – 1	24NCMC3TA1	Theatre Arts – 1
24NCMC3WM1	Western Music – 1	24NCMC3WD1	Western Dance – 1	24NCMC3FA1	Fine Arts – 1
24NCMC3MM1	Multimedia – 1				

SCHEME

SEMESTER: IV

Sl. No.	Course Type	Code	Course Title	Credits				Contact Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	BS	23MA4BSCPS	Complex Analysis, Probability and Statistical Methods	2	1	0	3	4	50	50	100
2	ES	23ES4ESCST	Control Systems*	2	1	0	3	4	50	50	100
3	PC	23EC4PCFAW	Fields and Waves	2	1	0	3	4	50	50	100
4	PC	23EC4PCAIC	Analog Integrated Circuits	3	0	0	3	3	50	50	100
5	PC/IPCC	23ES4PCAPP	ARM Processor and Programming**	3	0	1	4	5	50	50	100
6	PC/IPCC	23EC4PCPCS	Principles of Communication Systems	3	0	1	4	5	50	50	100
7	UHV	23MA4AEUHV	Universal Human Values	0	1	0	1	2	50	50	100
8	AE	23EC4AEAPL	Applied Python Programming Lab	0	0	1	1	2	50	50	100
9	NCMC	YYNCMC4XX2	NCMC – 2	–	–	–	–	2	–	–	P/NP
			Total	**15**	**4**	**3**	**22**	**31**	**400**	**400**	**800**

***Common to EC, EI & ET** ****Common to EC, EE, EI, ET & MD**

NCMC – 2:

Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
23NCMC4NS2	NSS – 2	23NCMC4YG2	Yoga – 2	23NCMC4PE2	Physical Education – 2
24NCMC4IM2	Indian Music – 2	24NCMC4ID2	Indian Dance – 2	24NCMC4TA2	Theatre Arts – 2
24NCMC4WM2	Western Music – 2	24NCMC4WD2	Western Dance – 2	24NCMC4FA2	Fine Arts – 2
24NCMC4MM2	Multimedia – 2				

SEMESTER: V

Sl. No.	Course Type	Code	Course Title	Credits				Contact Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	PC	23EC5PCFOV	Fundamentals of VLSI	3	0	0	3	3	50	50	100
2	PC	23EC5PCMTA	Microwave Theory and Antenna	3	1	0	4	5	50	50	100
3	PC	23EC5PCDSP	Digital Signal Processing	3	0	0	3	3	50	50	100
4	PC	23EC5PCDCT	Digital Communication Theory	3	0	1	4	5	50	50	100
5	HS	23CV5HSEVS	Environmental Studies*	1	0	0	1	1	50	50	100
6	PE	23EC5PE1XX	Professional Elective – 1	3	0	0	3	3	50	50	100
7	HS	23ES5HSPMF	Project Management and Finance*	2	0	0	2	2	50	50	100
8	PW	23EC5PWMPR	Mini Project	0	0	2	2	4	50	50	100
9	NCMC	YYNCMC5XX3	NCMC – 3	–	–	–	–	2	–	–	P/NP
			Total	**18**	**1**	**3**	**22**	**28**	**400**	**400**	**800**
Details of 40 AICTE Activity Points Earned											

***Common to EE, EC, ET, EI & MD**

Professional Elective – 1:

Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
23EC5PE1IP	Image Processing	23EC5PE1VR	Introduction to AR/VR	23EC5PE1AD	Advanced Digital Logic Design
23EC5PE1SC	Satellite Communication	23EC5PE1OS	Operating Systems	23EC5PE1IC	Information Theory for Cybersecurity
23EC5PE1AI	Introduction to AI	23EC5PE1IT	IoT and its Applications	23EC5PE1OP	Object Oriented Programming using C++

NCMC – 3:

Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
23NCMC5NS3	NSS – 3	23NCMC5YG3	Yoga – 3	23NCMC5PE3	Physical Education – 3
24NCMC5IM3	Indian Music – 3	24NCMC5ID3	Indian Dance – 3	24NCMC5TA3	Theatre Arts – 3
24NCMC5WM3	Western Music – 3	24NCMC5WD3	Western Dance – 3	24NCMC5FA3	Fine Arts – 3
24NCMC5MM3	Multimedia – 3				

SEMESTER: VI

Sl. No.	Course Type	Code	Course Title	Credits				Contact Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	PC	23EC6PCWCN	Wireless Communication and Networks	3	0	0	3	3	50	50	100
2	PC	23EC6PCCCN	Computer Communication Networks	3	0	1	4	5	50	50	100
3	PC	23EC6PCMSD	Mixed Signal Design	3	0	1	4	5	50	50	100
4	PE	23EC6PE2XX	Professional Elective – 2	3	0	0	3	3	50	50	100
5	OE	23EC6OE1XX	Open Elective – 1	3	0	0	3	3	50	50	100
6	AE	23ES6AERMI	Research Methodology and IPR*	2	0	0	2	2	50	50	100
7	AE	23EC6AEASP	Advanced Signal Processing Lab	0	0	1	1	2	50	50	100
8	PW	23EC6PWPJ1	Project Work – 1	0	0	2	2	4	50	50	100
9	NCMC	YYNCMC6XX4	NCMC – 4	–	–	–	–	2	–	–	P/NP
			Total	**17**	**0**	**5**	**22**	**29**	**400**	**400**	**800**
Details of 60 AICTE Activity Points Earned											

***Common to EC, ET & MD**

Professional Elective – 2:

Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
23EC6PE2CV	Computer Vision	23EC6PE2SV	System Verilog and Verification	23EC6PE2MC	Multi-core Computing
23EC6PE2RS	Radar System	23EC6PE2DE	Data Encryption and Compression	23EC6PE2WN	Wireless Sensor Networks
23EC6PE2ML	Machine Learning	23EC6PE2DS	Data Structures using C++	23EC6PE2VR	Design of Virtual Reality

Open Elective – 1:

Course Code	Course Title	Course Code	Course Title
23EC6OE1AE	Applied Electronics	23EC6OE1IR	Introduction to Robotics

NCMC – 4:

Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
23NCMC6NS4	NSS – 4	23NCMC6YG4	Yoga – 4	23NCMC6PE4	Physical Education – 4
24NCMC6IM4	Indian Music – 4	24NCMC6ID4	Indian Dance – 4	24NCMC6TA4	Theatre Arts – 4
24NCMC6WM4	Western Music – 4	24NCMC6WD4	Western Dance – 4	24NCMC6FA4	Fine Arts – 4
24NCMC6MM4	Multimedia – 4				

SEMESTER: VII

Sl. No.	Course Type	Code	Course Title	Credits				Contact Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	PC	23EC7PCESD	Embedded System Design	3	0	1	4	5	50	50	100
2	PC	23EC7PCECS	Electronics and Communication for Sustainable Development	2	0	0	2	2	50	50	100
3	PE	23EC7PE3XX	Professional Elective – 3	3	0	0	3	3	50	50	100
4	OE	23EC7OE2XX	Open Elective – 2	3	0	0	3	3	50	50	100
5	PW	23EC7PWPJ2	Project Work – 2	0	0	7	7	14	50	50	100
6	IKS	25MA7HSIKL	Indian Knowledge Systems*	1	0	0	1	1	50	50	100
			Total	**12**	**0**	**8**	**20**	**28**	**300**	**300**	**600**
Details of 80 AICTE Activity Points Earned											

***Common to all UG Programs**

Professional Elective – 3:

Course Code	Course Title	Course Code	Course Title
23EC7PE3SP	Speech Processing	23EC7PE3VR	3D modeling for Virtual Reality
23EC7PE3OC	Optical Communication	23EC7PE3SW	Steganography and Digital Watermarking
23EC7PE3PD	Physical Design	23EC7PE3DA	Data Analytics and Security in IoT
23EC7PE3FD	Firmware Design	23EC7PE3JS	Java Scripting
23EC7PE3DL	Deep Learning		

Open Elective – 2:

Course Code	Course Title	Course Code	Course Title
23EC7OE2PE	Power Electronics	23EC7OE2EM	Engineering Materials and Sensors
23EC7OE2SP	Signal Processing	23EC7OE2RS	Robotic Systems and Control

SEMESTER: VIII

Sl. No.	Course Type	Code	Course Title	Credits				Contact Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	PE	23EC8PE4XX	Professional Elective – 4	3	0	0	3	3	50	50	100
2	OE	23EC8OE3XX	Open Elective – 3	3	0	0	3	3	50	50	100
3	INT	23EC8SRINT	Internship	0	0	6	6	12	50	50	100
Total				**6**	**0**	**6**	**12**	**18**	**150**	**150**	**300**
Details of 100 AICTE Activity Points Earned											

Professional Elective – 4:

Course Code	Course Title	Course Code	Course Title
23EC8PE4MC	Multimedia Communication	23EC8PE4AI	Applications of AI
23EC8PE4NG	Next Generation Networks	23EC8PE4DS	Database Security and Access Control
23EC8PE4RT	Real-Time Systems	23EC8PE4MR	Applications of Mixed Reality
23EC8PE4LV	Low Power VLSI	23EC8PE45G	5G Enabled IoT
23EC8PE4UX	UI/UX Design		

Open Elective – 3:

Course Code	Course Title	Course Code	Course Title
23EC8OE3AE	Automotive Electronics	23EC8OE3IS	IoT for Structures
23EC8OE3AR	Applications of Robotics	23EC8OE3MT	Mobile Technology and Applications

III Semester Syllabus

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Course Title	**TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES**				
Course Code	**23MA3BSTFN**	**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 concepts of Series, Transform Techniques, Calculus of Variation and Finite Difference Methods to solve engineering problems.	1	–
CO2	**Apply** the concepts of Transform Techniques, Calculus of Variation and Finite Difference Methods in engineering using modern IT tools.	1, 5	–

UNIT – I

LAPLACE TRANSFORMS:
Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of derivatives and integrals. Laplace Transform of periodic functions (statement only) and unit-step function – Problems.
Inverse Laplace transforms: definition and problems. Solution of differential equations.

UNIT – II

FOURIER SERIES:
Introduction to trigonometric polynomial, trigonometric series. Dirichlet's conditions. Fourier series of periodic functions with period 2π and arbitrary period. Complex Fourier series. Practical harmonic analysis.

UNIT – III

FOURIER TRANSFORMS:
Definition and problems on Fourier Transform. Fourier sine and cosine transforms – Problems. Inverse Fourier transform, Inverse Fourier cosine and sine transforms - Problems. Convolution theorem (only statement) – problems.

UNIT – IV

NUMERICAL SOLUTION OF PDE:
Classification of second-order partial differential equations, finite difference approximation of derivatives. Solution of one-dimensional heat equation by Schmidt and Bendre-Schmidt explicit formulae. Solution of one-dimensional wave equation using finite difference method.

UNIT – V

CALCULUS OF VARIATIONS:
Definition, Variation of a functional, Euler-Lagrange equation, variational problems. Applications: Hanging cable problem, Brachistochrone problem.

***z*-TRANSFORMS**:
Definition, Standard z-transforms, Damping rule, Shifting rule. Inverse z-transform and applications – Solution of difference equations.

Text Books:

1. "Higher Engineering Mathematics", B. S. Grewal, 44th edition, 2018, Khanna Publishers.
2. "Advanced Engineering Mathematics", Erwin Kreyszig, 10th edition (reprint), 2016, John Wiley & Sons.

Reference Books:

1. "Higher Engineering Mathematics", B. V. Ramana, 11th Edition, 2007, McGraw-Hill Education.
2. "Engineering Mathematics", Srimanta Pal and Subodh C. Bhunia, 3rd reprint, 2016, Oxford University Press.
3. "A Textbook of Engineering Mathematics", N. P. Bali and Manish Goyal, Laxmi Publications.
4. "Advanced Engineering Mathematics", C. Ray Wylie and Louis C. Barrett, 6th edition, McGraw-Hill Book Company, New York.
5. "Engineering Mathematics for Semester I and II", Gupta C. B., Sing S. R. and Mukesh Kumar, 2015, McGraw-Hill Education (India).
6. "Higher Engineering Mathematics", H. K. Dass and Rajnish Verma, 2014, S. Chand Publication.
7. "Calculus", James Stewart, 7th edition, 4th reprint, 2019, Cengage Publications.

E-Books and Online Course Material:

1. `http://www.class-central.com/subject/math` (MOOCs)
2. `http://academicearth.org/`
3. `http://www.bookstreet.in/`
4. VTU e-Shikshana Program
5. VTU EDUSAT Program

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Course Title	HDL PROGRAMMING				
Course Code	23EC3ESHDL	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, the student 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 Verilog HDL modeling.	2	3
CO3	**Design** and synthesize a digital circuit for complex systems using Verilog HDL and state machines.	3	3

UNIT – I

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

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

UNIT – III

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

UNIT – IV

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

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.

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. http://access.ee.ntu.edu.tw/course/dsd_99second/2011_lecture/W2_HDL_Fundamentals_2011-03-02.pdf
2. http://www.ics.uci.edu/œalexv/154/VHDL-Cookbook.pdf
3. http://ece.niu.edu.tw/œchu/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/
3. Fundamentals of HDL (Lecture #008): https://www.youtube.com/watch?v=rdAPXzxeaxs&index=8&list=PLE3BC3EBC9CE15FB0

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Course Title	ANALOG ELECTRONIC CIRCUITS				
Course Code	23EC3PCAEC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Elements of Electronics Engineering

Course outcomes: At the end of the course, the student 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).	–	–
CO2	**Apply** the knowledge of network theorems and device models to solve given analog electronic circuits.	1	1, 3
CO3	**Analyze** a given analog electronic circuit to compute required parameters.	2	1, 3
CO4	**Design** analog electronic circuits for a given specification.	3	1, 3
CO5	**Submit** a report and give a presentation on recent technological development in the Analog Electronics domain	10, 12	1, 3

UNIT – I

Diode applications: 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, the r_e Transistor model, Voltage Divider Bias.

UNIT – II

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

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, Amplifier Distortion.

UNIT – IV

MOSFETs: Introduction, Device structure, and physical operation - Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDs, Operation as VDs 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

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 gm, 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.

Text Books:

1. "Electronic Devices and Circuit Theory," Robert L. Boylestad and Louis Nashelsky, 10th edition (PEARSON EDUCATION).
2. "Microelectronic Circuits-Theory and applications" by Adel S. Sedra and Kenneth C. Smith, Fifth Edition (OXFORD INTERNATIONAL STUDENT EDITION).

Reference Books:

1. "Electronic Devices and Circuits," Millman and Halkias, TMH.
2. "Electronic Devices and Circuits," David A Bell - PHI 4th edition.
3. "Integrated Electronics," Jacob Millman, Christos Halkias and Chetan Parikh, 2nd edition, McGraw Hill Education.

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 courseware Reviews and Ratings.

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Course Title	DIGITAL CIRCUIT DESIGN				
Course Code	23EC3PCDCD	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Elements of Electronics Engineering

Course outcomes: At the end of the course, the student will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	**Apply** the fundamental logic functions to realize basic building blocks of digital logic design	1	2, 3
CO2	**Analyse** the digital logic circuits and optimize with cost effective solutions	2	2, 3
CO3	**Design** a complete digital circuit for given specification using digital circuit concepts	3	2, 3

UNIT – I

Introduction to Boolean algebra, Simplification of Boolean functions, K-Maps: Three Variable and Four Variable, Design with Basic gates, NAND gates and NOR gates .

UNIT – II

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

UNIT – III

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

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

UNIT – V

Algorithmic State Machine: Introduction, ASM Charts, Synchronous sequential network design with ASM charts, State Assignment, ASM table, ASM realization, Asynchronous Inputs.

Text Books:

1. Digital Logic and Computer Design- M. Morris Mano, Prentice Hall – Pearson Education
2. Digital Principles and Design- Donald Givone, Tata McGraw Hill
3. Digital Principles and Applications- Donald P Leach, Albert Paul Malvino, Goutam Saha, 7th Edition, Tata McGraw 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

MOOCs:

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

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Course Title	SIGNALS AND SYSTEMS				
Course Code	23EC3PCSAS	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	**Apply** the mathematical concepts and transform techniques to solve the continuous and discrete LTI systems	1	2
CO2	**Analyze** various methods to categorize the LTI systems and identify solutions for mathematical representations of systems	2	2
CO3	**Design** a linear, time-invariant system for a given specification	3	2
CO4	**Simulate and Conduct** experiments involving various operations on signals and response of systems using appropriate tools	5	2

UNIT – I

Signals: Definition of Signals, Classification of Signals, Basic Operations on Signals: Operations Performed on the Independent and Dependent Variable, Precedence Rule, Elementary Signals.

UNIT – II

Systems: Definition of Systems, System Viewed as Interconnection of Operations, Properties of Systems: Linearity, Time Invariance, Memory, Causality, Stability and Invertibility with numerical problems.

UNIT – III

Time domain representations of Linear Time Invariant Systems: Introduction: Impulse response representation of LTI systems, Properties of impulse response representation of LTI systems, Differential and Difference equation representation for LTI systems, Block diagram representation of Continuous time systems.

UNIT – IV

Application of Fourier Representation for signals: Discrete Time Fourier Series, Properties of DTFS, Discrete Time Fourier Transform, Properties of DTFT, Frequency response of LTI Systems, Sampling, Application of DTFT.

UNIT – V

Applications of z-transform: Transform Analysis of LTI Systems using z-transform, Relating the transfer function and difference equation, Causality and stability, Inverse Systems, Determining the frequency response from poles and zeros, Computational structures for implementing Discrete Time Systems, Unilateral z-transform and solution of difference equations.

Text Books:

1. "Signals and Systems", Simon Haykin and Barry Van Veen, 2nd Edition, 2008, John Wiley & Sons.

Reference Books:

1. "Signals and Systems", H. P. Hsu and R. Ranjan, Schaum's Outlines, 2006, Tata McGraw-Hill.
2. "Fundamentals of Signals and Systems", Benoit Boulet, 2006, Thomson.
3. "Signals and Systems", Uday Kumar S., Third Edition, 2004, Elite Publishers.
4. "Signals and System", D. Ganesh Rao and Satish Tunga, Fourth Edition, 2008, Sanguine Technical Publishers.

E-Books:

1. https://www.amazon.in/Signals-Systems-Oppenheim-Willsky-Hamid/dp/9332550239
2. https://www.amazon.in/SIGNALS-SYSTEMS-2nd-H-Hsu/dp/007066918X

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.htm
2. NPTEL online course modules – By Prof. Aditya K. Jagannatham — IIT Kanpur Principles of Signals and Systems - Course (nptel.ac.in)

List of Lab Experiments

1. Program to create, display and modify a matrix
2. Programs on arithmetic operations on matrix
3. Program to solve system of linear equations
4. Program to generate elementary, continuous and discrete signals
5. Program on basic operations on continuous and discrete signals
6. Program to find linear convolution of two sequences
7. Given the input signal, program to find the response of a system
8. For a given network circuit find the impulse response and unit step response of a system
9. Program to perform verification of properties of convolution sum
10. Program to compute frequency response of a system
11. Programs to find z-transform and inverse z-transform of a sequence. Simulate pole-zero plot.

12. Program to solve difference equation (up to 2nd order)
13. Program to simulate frequency and power spectrum of time-domain signals using Fourier Transform
14. Open ended experiments as assignments in Lab Sessions

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Course Title	**NETWORK ANALYSIS**				
Course Code	**23ES3PCNAL**	**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** basic circuit laws and network theorems to linear electrical networks	1	1, 3
CO2	**Analyse** linear circuits in time and frequency domain	2	1, 3
CO3	**Simulate** linear circuits using appropriate tools	5	1, 3

UNIT – I

Basic Concepts: Active and passive elements, Concept of ideal and practical sources. Source transformation and Source shifting, Concept of Super-Mesh and Super node analysis. Analysis of networks by (i) Network reduction method including star-delta transformation, (ii) Mesh and Node voltage methods for AC and DC circuits with independent and dependent sources.

UNIT – II

Network Theorems: Super Position theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem.

UNIT – III

Resonant Circuits: Analysis of simple series RLC and parallel RLC circuits under resonances. Problems on Resonant frequency, Bandwidth and Quality factor at resonance, Duality of networks.

UNIT – IV

Laplace Transformation: Laplace transformation (LT), LT of Impulse, Step, Ramp, Waveform synthesis. Initial and Final value theorems. solution for RL, RC networks for DC excitation.

Transient Analysis: Transient analysis of RL and RC circuits under DC excitations: Behaviour of circuit elements under switching action ($t = 0$ and $t = \infty$), Evaluation of initial conditions.

UNIT – V

Two Port Network and its Parameters: Definition, Open circuit impedance, short circuit admittance, hybrid and Transmission parameters. Relation between the different parameters. Evaluation of electrical circuits for Independent sources only.

Text Books:

1. "Network Analysis", Van Valkenburg M.E., Prentice Hall India, 2014.
2. "Circuit Theory Analysis and Synthesis", Chakrabarti, A., Dhanpat Rai & Co., 7th Revised Edition, 2018.

Reference Books:

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

E-Books and Online Course Material:

1. `https://www.pdfdrive.com/introduction-to-electrical-circuit-analysis-e195167204.html`

MOOCs:

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

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Course Title	BIOLOGY FOR ENGINEERS				
Course Code	23ES3BSBFE	Credits	1	L – T – P	1:0:0
CIE	50 Marks (100% weightage)		SEE	50 Marks (100% weightage)	

Course Objectives: At the end of the course, the student will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	**Understand** Biological concepts from an engineering perspective	–	–
CO2	**Familiarize** with the concepts of biological sensing, bio-printing techniques and materials and the role of Artificial Intelligence for disease diagnosis	1	–
CO3	**Understand** the basics of radiation and its effects on Human Body	6, 7	–

Sensing Techniques: Understanding of Sense organs working – Sensing mechanisms – Sensor Development issues – Physiological Assist Device: Artificial Organ Development: Kidney, Liver, Pancreas, heart valves – Design Challenges and Technological developments.

Nature-bio-inspired mechanisms (qualitative): Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces).

Bio printing techniques and materials: 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bio imaging and Artificial Intelligence for disease diagnosis.

Introduction to Radiation: Source and 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. Penetrating Power of Radiation within the Body, Penetrating Power and Range of Effects on the Human Body.

Radiation Effects on Human Body: Types of Effects, Exposure Modes and Effects Classification of Radiation Effects Deterministic Effects and Stochastic Effects, Mutation, Mechanism of Causing Effects on Human Body. Ionization due to Radiation, Damage and Repair of DNA. Radio sensitivity of Organs and Tissues.

Reference Books:

1. "Human Physiology," Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022.
2. "Biology for Engineers," Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.

3. "Biomedical Instrumentation," Leslie Cromwell, Prentice Hall 2011.
4. "Biomimetics: Nature-Based Innovation," Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
5. "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies," D. Floreano and C. Mattiussi, MIT Press, 2008.
6. "3D Bioprinting: Fundamentals, Principles, and Applications" by Ibrahim Ozbolat, Academic Press, 2016.
7. "Electronic Noses and Tongues in Food Science," Maria Rodriguez Mende, Academic Press, 2016.

Online Resources:

1. VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
2. https://nptel.ac.in/courses/121106008
3. https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
4. https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
5. https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
6. https://www.coursera.org/courses?query=biology
7. https://onlinecourses.nptel.ac.in/noc19_ge31/preview
8. https://www.classcentral.com/subject/biology
9. https://www.futurelearn.com/courses/biology-basic-concept

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Course Title	INTEGRATED ELECTRONICS LAB				
Course Code	23EC3PCIEL	Credits	1	L – T – P	0:0:1
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	**Apply** the knowledge of network theorems, device models and basics of analog and digital electronics to conduct a given experiment	1	1, 3
CO2	**Identify** and **analyse** analog and digital electronic circuits to obtain the expected output for the given parameters	2	1, 3
CO3	**Design** analog and digital electronic circuits for the given specifications and conduct the experiment	3	1, 3
CO4	**Involve** in independent / team learning, communicate effectively and engage in life long learning	9, 10, 12	1, 3

List of Analog Electronics Experiments

1. Implementation and verification of Diode and Transistor as Switch
2. Design and testing of clipper circuits to generate the required waveform
3. Design and verification of Clamping Circuits
4. Design and testing of crystal oscillator
5. Design of Class B Complementary symmetry Power Amplifier
6. Design and Verification of Amplifiers using OP-AMP
7. Design and verification of Zener diode as voltage regulator
8. Design and Verification of RC-Coupled amplifier determine gain, frequency response, input and output impedance.

List of Digital Electronics Experiments

9. Realization of Full adder using MUX and DEMUX
10. Design and Realization of MOD-N counter using 7493

11. Simplification and realization of Boolean expression
12. Realization of shift register using 7495 and use it for
    (i) Shift right operation (SIPO, SISO, PISO, PIPO)
    (ii) Shift left operation.

Reference Books:

1. "Electronic Devices and Circuit Theory", Robert L. Boylestad and Louis Nashelsky, 10th Edition, Pearson Education.
2. "Digital Principles and Design", Donald Givone, Tata McGraw Hill.

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Course Title	**HDL PROGRAMMING LAB**				
Course Code	**23EC3AEHPL**	**Credits**	**1**	**L – T – P**	**0:0:1**
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	**Apply** the knowledge of HDL programming for modeling and functional verification of Digital circuits using EDA tools.	1, 5	3
CO2	**Analyse** digital circuits using suitable Verilog HDL modeling using EDA tools.	2, 5	3
CO3	**Design** and synthesize a digital circuit for complex systems using EDA tools.	3, 5	3
CO4	**Involve** in independent / team learning, communicate effectively and engage in life long learning	9, 10, 12	3

List of Experiments

1. Introduction to Vivado FPGA Tool Suite
2. Gate-level modelling: Half adder, Full adder
3. Gate-level modelling: Multiplexers and demultiplexers
4. Gate-level/Dataflow modelling: Decoders
5. Dataflow modelling for 2-bit magnitude comparator
6. Data flow modelling: Ripple Carry adder
7. Dataflow modelling: Carry Look-ahead Adder
8. Structural Modelling: Multibit Subtractor (using Adder)
9. Behavioural modelling for multibit magnitude comparator
10. Behavioural modelling for Encoder with and without priority
11. Behavioural modelling: SR latch, JK and D flip-flops
12. Behavioural modelling: Universal Shift Register
13. Behavioural modelling: Synchronous Counters
14. Structural Modelling: Asynchronous counters

15. Behavioural modelling: Sequence detection

Text Books:

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

Reference Books:

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

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Course Title	**ADDITIONAL MATHEMATICS – I** (For lateral entry students)				
Course Code	**22MA3BSMAT**	**Credits**	**0**	**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	**Demonstrate** the concepts of Differential Calculus and Integral Calculus.	1	–
CO2	**Apply** the concepts of differential calculus to solve ordinary and partial differential equations	1	–

UNIT – I

DIFFERENTIAL AND INTEGRAL CALCULUS:
List of standard derivatives including hyperbolic functions, rules of differentiation. Polar curves, angle between the radius vector and the tangent, angle between two curves (No proof). Taylor's and Maclaurin's series expansion for one variable (Statement only) – problems. List of standard integrals, integration by parts. Definite integrals-problems.

UNIT – II

MULTIVARIATE CALCULUS:
Partial differentiation, total derivative-differentiation of composite functions. Jacobian and problems.

Vector Differentiation: Scalar and vector fields. Gradient, directional derivative, curl and divergence - physical interpretation, solenoidal and irrotational vector fields. Problems.

UNIT – III

ORDINARY DIFFERENTIAL EQUATIONS (ODE's) OF FIRST ORDER:
Bernoulli's differential equations. Exact and reducible to exact differential equations. Applications of ODE's – Orthogonal trajectories.

Nonlinear differential equations: Introduction to general and singular solutions; Solvable for p only.

UNIT – IV

ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER:
Higher-order linear ODE's with constant coefficients – Inverse differential operator, method of variation of parameters, Cauchy's and Legendre homogeneous differential equations. Problems.

UNIT – V

PARTIAL DIFFERENTIAL EQUATIONS (PDE's):
Formation of PDE's by elimination of arbitrary constants and functions. Solution of non homogeneous PDE by direct integration. Solution of PDE by the method of separation of variables. Solution of Lagrange's linear PDE. Derivation of one-dimensional heat equation and wave equation.

Text Books:

1. "Higher Engineering Mathematics", B. S. Grewal, 44th edition, 2018, Khanna Publishers.
2. "Advanced Engineering Mathematics", Erwin Kreyszig, 10th edition (reprint), 2016, John Wiley & Sons.

Reference Books:

1. "Higher Engineering Mathematics", B. V. Ramana, 11th Edition, 2007, McGraw-Hill Education.
2. "Engineering Mathematics", Srimanta Pal and Subodh C. Bhunia, 3rd reprint, 2016, Oxford University Press.
3. "A Textbook of Engineering Mathematics", N. P. Bali and Manish Goyal, Laxmi Publications.
4. "Advanced Engineering Mathematics", C. Ray Wylie and Louis C. Barrett, 6th edition, McGraw-Hill Book Company, New York.
5. "Engineering Mathematics for Semester I and II", Gupta C. B., Sing S. R. and Mukesh Kumar, 2015, McGraw-Hill Education (India).
6. "Higher Engineering Mathematics", H. K. Dass and Er. Rajnish Verma, 2014, S. Chand Publication.
7. "Calculus", James Stewart, 7th edition, 4th reprint, 2019, Cengage Publications.

E-Books and Online Course Material:

1. `http://nptel.ac.in/courses.php?disciplineID=111`
2. `http://www.class-central.com/subject/math` (MOOCs)
3. `http://academicearth.org/`
4. VTU e-Shikshana Program
5. VTU EDUSAT Program

IV Semester Syllabus

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Course Title	**COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS**				
Course Code	**23MA4BSCPS**	**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 concepts of complex variables, special functions, probability and statistics to solve engineering problems.	1	–
CO2	**Apply** the concepts of complex variables, special functions and statistical methods using modern IT tools.	1, 5	–

UNIT – I

COMPLEX ANALYSIS:
Review of a function of a complex variable, limits, continuity and differentiability.

Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences. Construction of analytic functions by Milne-Thomson method.

Complex integration: Line integral of a complex function, Cauchy's theorem and Cauchy's integral formula and problems.

Conformal mapping: $w = z^2$ and $w = z + \dfrac{k^2}{z} (z \neq 0)$.

UNIT – II

SPECIAL FUNCTIONS:
Introduction, Ordinary and Singular Points, Series solution of Bessel's differential equation leading to $J_n(x)$, Bessel's function of the first kind, Properties, generating function for $J_n(x)$. Series solution of Legendre's differential equation leading to $P_n(x)$. Legendre polynomials, Rodrigue's formula (without proof) – Problems.

UNIT – III

STATISTICAL METHODS:
Curve Fitting: Fitting the straight line, parabola and geometric curve ($y = ax^b$) by the method of least squares.

Correlation and regression: Karl Pearson's coefficient of correlation and rank correlation. Lines of regression, angle between two regression lines.

UNIT – IV

PROBABILITY DISTRIBUTIONS:
Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions. Mathematical expectation, mean and variance. Poisson and normal distributions.

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance and correlation.

UNIT – V

STATISTICAL INFERENCE:
Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means (single mean and difference between two means), student's t-distribution (single mean and difference between two means), Chi-square distribution-goodness of fit.

Text Books:

1. "Higher Engineering Mathematics", B. S. Grewal, 44th edition, 2018, Khanna Publishers.
2. "Advanced Engineering Mathematics", Erwin Kreyszig, 10th edition (reprint), 2016, John Wiley & Sons.

Reference Books:

1. "Advanced Engineering Mathematics", C. Ray Wylie and Louis C. Barrett, 6th edition, McGraw-Hill Book Company, New York.
2. "Higher Engineering Mathematics", B. V. Ramana, 11th Edition, 2007, McGraw-Hill Education.
3. "A Textbook of Engineering Mathematics", N. P. Bali and Manish Goyal, Laxmi Publications.
4. "Advanced Engineering Mathematics", Chandrika Prasad and Reena Garg, 2018, Khanna Publishing.

E-Books and Online Course Material:

1. `http://nptel.ac.in/courses.php?disciplineID=111`
2. `http://www.class-central.com/subject/math` (MOOCs)
3. `http://academicearth.org/`
4. `http://www.bookstreet.in/`
5. VTU EDUSAT Program – 20
6. VTU e-Shikshana Program

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Course Title	CONTROL SYSTEMS				
Course Code	23ES4ESCST	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 engineering fundamentals to form mathematical model and obtain transfer function/state space representation of a system.	1	2
CO2	**Analyse** the stability of LTI systems in time/frequency domain using different techniques	2	2
CO3	**Investigate** the stability of LTI systems in the time/frequency domain as a team/an individual using modern tools	3, 5	2

UNIT – I

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

Mathematical Modelling of Linear Systems: Transfer functions, Transfer function of electrical circuits, Block diagram, Signal Flow graph.

UNIT – II

Time response analysis: Step response of first order, second order systems, response specification, steady state error and error constants.

UNIT – III

Stability Analysis: Concept of stability, R-H criterion, applications of R-H criterion with limitations.

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

UNIT – IV

Frequency response Analysis: Frequency domain specification, Polar plots, Nyquist plot, Stability Analysis using Nyquist criterion, Bode plots, GM and PM, Stability Analysis using Bode Plot.

UNIT – V

State Variable Analysis: Concept of state variables, physical variable model, phase variable model, obtaining transfer function from state model.

Text Books:

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

Reference Books:

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

E-Books and Online Course Material:

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

MOOCs:

1. https://swayam.gov.in/explorer
2. https://www.edx.org/course

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Course Title	FIELDS AND WAVES				
Course Code	23EC4PCFAW	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 principles of Electrostatics and Magnetostatics to obtain the field, potential and boundary conditions; and Maxwell's equations to study electromagnetic wave propagation in different media	1	1, 2
CO2	**Analyse** and solve Electromagnetic problems related to Electrostatics, Magnetostatics, Time-varying fields and wave propagation	2	1, 2
CO3	**Engage** in self-learning through online/multimedia resources and by working on mini-projects related to electromagnetic fields and waves	9, 10, 12	1, 2

UNIT – I

Electrostatics: Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss' Law and Applications, Electric field due to line charge, sheet charge and volume charge, Divergence Theorem. Energy spent in moving a charge in an Electric field, Definition of Potential and Potential Difference, Potential gradient, Energy Density.

UNIT – II

Electrostatics: Electric field due to dipole, Properties of Conductors and Dielectrics, Continuity equation for Current, Boundary Conditions. Poisson's equation, Laplace's equation and its solution for Single Variables. Capacitance of parallel-plate, annular ring and concentric spheres.

UNIT – III

Steady Magnetic Field: Biot-Savart Law, Ampere's Circuital Law, Magnetic Flux and Flux Density. Force on a moving charge, Force on differential current element, Magnetic Boundary Conditions.

UNIT – IV

Time varying fields: Faraday's Law, Displacement Current, Maxwell's Equations in Point and Integral Form.
Wave Propagation: Uniform plane wave propagation through free space, Wave propagation through dielectrics, Poynting's Theorem, Propagation in Good conductors, skin depth, Wave polarization.

UNIT – V

Plane Wave Reflection and Dispersion: Reflection at normal incidence, Standing Wave Ratio, Plane Wave propagation in general directions, Reflection at Oblique incidence, Wave propagation and Pulse broadening in dispersive media.

Text Books:

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

Reference Books:

1. "Electromagnetics with Applications", John Krauss and Daniel A Fleisch, 5th Edition, 1999, McGraw-Hill.
2. "Classical Electromagnetism", H. C. Verma, 1st Edition, 2022, Bharati Bhawan Publishers.
3. "Elements of Electromagnetics", Mathew N. O. Sadiku, 2014, Oxford University Press.

E-Books and Online Course Material:

1. "Electromagnetic Field Theory: A Problem Solving Approach", Markus Zahn, 2008. https://hibp.ecse.rpi.edu/~connor/education/Fields/Zahn/electromagnetic_field_theory_mod2_tag.pdf

MOOCs:

1. Classical Electromagnetics-1, Prof. H. C. Verma, https://bsc.hcverma.in/cee1/#/home
2. Classical Electromagnetics-2, Prof. H. C. Verma, https://bsc.hcverma.in/cee2/#/home

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Course Title	**ANALOG INTEGRATED CIRCUITS**				
Course Code	**23EC4PCAIC**	**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	**Define, understand** and **explain** the DC and AC performance characteristics of op-amp, applications of op-amp.	–	–
CO2	**Apply** the knowledge of network theorems to analog integrated circuits.	1	1, 3
CO3	**Analyze** analog integrated circuits to obtain the response at different points that meet desired specifications	2	1, 3
CO4	**Design** an analog circuit for given problem statement by applying the analog integrated circuit concepts	3	1, 3

UNIT – I

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

Operational Applications: Instrumentation Applier, V to I and I to V converter, Op-amp circuits using Diodes – Half wave rectifiers, Full wave rectifier, Peak detector, Sample and hold circuit.

UNIT – II

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

UNIT – III

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

D/A 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

Timers: Functional block diagram of 555, Applications: Astable and Monostable multi-vibrators, Ramp generator.

Phase locked loops: Introduction, Basic principles, phase detector/comparator, voltage controlled oscillator (VCO).

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 Age Publication.

Reference Books:

1. "Op-Amps and Linear ICs", David A. Bell, Prentice-Hall 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/

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Course Title	ARM PROCESSOR AND PROGRAMMING				
Course Code	23ES4PCAPP	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisities: Digital Electronic Circuits

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

Sl. No.	Course Outcomes	PO	PSO
CO1	**Apply** knowledge of combinational, sequential, and timing circuits in recognizing functional blocks of computers and their working *mechanisms*	1	2
CO2	**Analyse** the Architectural features of 32-bit microprocessor with necessary Input/Output and Memory Operations to build an embedded Controller	2	2
CO3	**Design** simple programming modules in machine and higher-level programming language using simulators to develop logical skills *and testing skills*	3	2
CO4	**Select and implement** appropriate Structured and *modular* programming using techniques such as subroutines, *data stores*, interrupt service routines and *exception handling mechanisms*	4	2
CO5	**Build** simple Embedded Applications using Input and output devices with ARM core and a controller	5	2

UNIT – I

ARM Processor fundamentals: Basic Structure of computers- Von Neumann and Harvard Architecture, Basic Processing Unit, Bus Structure, RISC and CISC Architecture, RISC and ARM Design philosophy, ARM core Dataflow model, programming model, processor states and operating modes, ARM pipeline.

UNIT – II

ARM Assembly Programming: load/store architecture, ARM instruction set, Assembler rules and Directives, ARM-THUMB interworking, Assembly Language Programs.

UNIT – III

Embedded C Programming: Basic C data types, Local variable types, C compiler, Optimization; C looping and structures, Registrar allocation, function calls, Writing and optimizing assembly codes, mixing C and Assembly programming, Instruction scheduling.

UNIT – IV

Subroutines and stacks: Introduction, stack, subroutines, passing parameters to Subroutines, Exception and interrupt handling- Vector Table, Exception priorities, link register offsets, interrupts. Interrupt handling schemes-Non Nested.

UNIT – V

Application of ARM controller LPC 2148: Memory map, memory and I/O mapped peripherals, ADC, DAC and UART-Interfacing Programs, firmware and boot loader, introduction to Embedded Operating System

Text Books:

1. "Computer Organization and Architecture", Carl Hamacher, Zvonko Vranesic, 2001, McGraw-Hill.
2. "ARM System Developer's Guide", Sloss, Symes and Wright, Morgan Kaufmann Publishers, 2005, Elsevier.
3. "ARM Assembly Language- Fundamentals and Techniques", William Hohl, 2009, CRC press, Taylor and Francis.

Reference Books:

1. "Computer Organisation & Architecture", William Stallings, 2010, PHI.
2. "ARM System On-Chip Architecture", Steve Furber, Seocnd Edition, 2010, Pearson.

E-Books and Online Course Material:

1. ARM Microprocessor Systems, `https://www.pdfdrive.com/arm-microprocessor-systems-cortex-m-architecture-programming-and-interfacing-e157100364.html`

MOOCs:

1. `https://www.arm.com/resources/education/online-courses`

List of Lab Experiments

1. Divide an 8-bit variable into two 4 bit nibbles and store one nibble in each byte of a 16 bit variable. Store the disassembled byte in memory location (pointed by result)
2. Compare 2 values stored in memory location and store the higher value in a memory location (pointed by result)
3. Write a program to add two 64-bit numbers and store the result in a memory location.
4. Add a series of 16-bit numbers stored in sequential location in memory (called Table) and store the result in memory

5. Find the factorial of a given number
6. Write an assembly language program using the ARM instruction set to find the largest in a series of numbers stored in memory. Store the largest number in a memory location
7. ALP to multiply two 16 bit binary numbers.
8. ALP to find the sum of the first 10 integer numbers.
9. Write a program in C for the ARM processor to read data from the 8-bit on-board DIP switch and display the value on the 8 LEDs
10. Write a program in C for the ARM processor to use the built-in DAC to generate the following waveforms - square, ramp, triangle, and sine
11. Write a program in C for the ARM processor to rotate the stepper motor in both directions.
12. Establish serial communication between the ARM kit and the PC and do the following:
    (i) Send a character from the ARM kit to the serial terminal on the PC
    (ii) Send a character from the PC to the ARM Kit and display it on the LED
    (iii) Send a character from the PC to the ARM Kit. The program on the ARM processor should add 2 to it and send it back to the PC

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Course Title	PRINCIPLES OF COMMUNICATION SYSTEMS				
Course Code	23EC4PCPCS	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisities: 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	2
CO2	**Analyze** performance of different types of Analog modulation Techniques for a given set of parameters	2	2
CO3	**Design** Analog Communication subsystems for given set of specifications	3	2
CO4	**Simulate and conduct** experiments on different types of Analog communication subsystems	4, 5	2
CO5	**Involve** in independent/team learning, Communicate effectively and engage in life-long learning.	9, 10, 12	2

UNIT – I

Amplitude Modulation: Introduction to communication system, Channel: Types, Characteristics, and Modelling. Modulation Techniques: Need for modulation, Types of Modulation (AM, FM, PM, PAM, PWM, PPM). Amplitude modulation Time domain and frequency domain description, single tone modulation, power relations in amplitude modulation waves; Generation of amplitude modulation wave using, square law and switching modulators; Detection of amplitude modulation waves using square law and envelope detectors.

UNIT – II

Double Side Band Suppressed Carrier & SSB Modulation:

Double side band modulation: Time domain and frequency domain description; Generation of DSBSC waves using Ring modulators; Coherent detection; Costas loop; Quadrature Carrier Multiplexing.

Single Side Band Modulation: Time & Frequency domain description, Generation of SSB-SC frequency discrimination method; Phase discrimination method; Vestigial side band modulation: Time & Frequency description, generation; Envelope detection; Comparison of AM techniques; Applications of AM systems.

UNIT – III

Angle Modulation: Single tone frequency modulation, Spectrum analysis of sinusoidal frequency modulation wave, narrow band frequency modulation, wide band frequency modulation, transmission bandwidth of frequency modulation wave, phase modulation, comparison of frequency modulation and phase modulation; Generation of frequency modulation waves, direct frequency modulation and indirect frequency modulation, Zero Crossing Detector, FDM, Frequency Translation. Comparison of FM & AM.

UNIT – IV

Noise performance of Analog modulation schemes: Noise sources, Types, Receiver characteristics: Sensitivity, Selectivity, Image Frequency Rejection Ratio, Choice of intermediate frequency, fidelity, Signal to Noise Ratio, Receiver model, Noise figure, Noise in AM, DSB & SSB System, Noise in Angle Modulation Systems, Threshold effect in Angle Modulation System, Pre-emphasis & De-emphasis.

UNIT – V

Introduction to Digital Communication: Introduction, Sampling theorem, Quadrature Sampling of Band pass signals, Practical aspects of sampling and signal recovery, PAM, TDM.

Text Books:

1. "Communication Systems", Simon Haykin and Moher, 5th Edition, 2010, Wiley.
2. "An Introduction to Analog and Digial Communications", Simon Haykin, 2008, Wiley.

Reference Books:

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

MOOCs:

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

List of Lab Experiments

1. Conduction of Second Order filters – LPF, HPF, BPF, BEF
2. Class C tuned amplifier
3. Generation and detection of AM
4. Generation and detection of DSBSC waves
5. FM Wave generation
6. Conduction on Frequency Mixer
7. Generation and Detection of PAM, PWM, PPM
8. Verification of sampling theorem

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Course Title	UNIVERSAL HUMAN VALUES				
Course Code	23MA4AEUHV	Credits	1	L – T – P	0:1:0
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	**Conduct** self-exploration and distinguish between values and skills, happiness and accumulation of physical facilities, the self and the body, Intention and Competence of an individual	1, 12	–
CO2	**Analyse** the value of harmonious relationship based on trust and respect in personal and professional life	2, 9	–
CO3	**Examine** the role of a human being in ensuring harmony in society and nature	2, 10	–
CO4	**Apply** the understanding of ethics in life and profession	1, 8	–

UNIT – I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration – what is it? Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity – A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility – the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly – A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT – II

Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health v/s dealing with disease.

UNIT – III

Understanding Harmony in the Family and Society – Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

UNIT – IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence: Understanding the harmony in the Nature.

Holistic perception of harmony at all levels of existence.

UNIT – V

Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist *etc*.

Text Books:

1. "Human Values and Professional Ethics", R. R. Gaur and G. P. Bagaria, 2010, Excel Books, New Delhi.

Reference Material:

1. "Jeevan Vidya: Ek Parichaya", A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. "Human Values", A.N. Tripathi, New Age International Publishers, New Delhi, 2004.
3. "The Story of Stuff", Annie Leonard.
4. "The Story of My Experiments with Truth", Mohandas Karamchand Gandhi
5. "Small is Beautiful", E. F. Schumacher
6. "Slow is Beautiful", Cecile Andrews
7. "Economy of Permanence", J. C. Kumarappa
8. "Bharat Mein Angreji Raj", Pandit Sunderlal
9. "Rediscovering India", Dharampal
10. "Hind Swaraj or Indian Home Rule", Mohandas K. Gandhi
11. "India Wins Freedom", Maulana Abdul Kalam Azad
12. "Vivekananda", Romain Rolland (English)

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Course Title	APPLIED PYTHON PROGRAMMING LAB				
Course Code	23EC4AEAPL	Credits	1	L – T – P	0:0:1
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** Python libraries, OOP Concepts in Python Programming	–	–
CO2	**Apply** different mathematical concepts: Probability and Statistics, Laplace, Fourier and z-Transforms using python IDE platform (Jupyter notebook, pycharm, *etc*.)	1	2
CO3	**Implement** real-time applications in signal analysis and control systems	2, 3	2

List of Experiments

- **Basics of Python and Python Modules**

1. Program to find the best of two test average marks out of three test's marks accepted from the user.
2. Program to generate a Fibonacci sequence up to specified length.
3. Develop a program to check whether a given number/character is Palindrome or not.
4. Develop a program to convert Decimal to binary, Octal and Hexa-decimal and vice-versa using functions and Loops.

- **OOPS Concepts in Python Programming: Classes, Objects and Inheritance**

5. Declare a base class to calculate Resistance from voltage and current and extend the class to calculate inductance and capacitance with varying voltage and current values with respect to time.
6. By using the concept of inheritance, write a program to find the area of triangle, circle and rectangle.

- **Application to Field Theory**

7. Demonstration of electric field lines due to a point charge
8. Standing waves animation

- **Application to signals and systems and control systems**

9. Develop a Program for Sine Wave Generation.
10. Program to display pole – zero plot for a given transfer function.
11. Program to solve a given 2nd order difference equation using Z transform.
12. Program to solve a given 2nd order differential equation using Laplace transform.
13. Program to display Bode plot for a given second order system.
14. Program to display Nyquist plot for a given second order system.

Reference Books:

1. "Python Cookbook", David Beazley and Brian K. Jones, 3rd Edition, 2013, O'Reilly Media Inc.
2. "Python: The Complete Reference", Martin C. Brown, 4th Edition, 2018, McGraw-Hill.

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Course Title	**ADDITIONAL MATHEMATICS – II** (For lateral entry students)				
Course Code	**22MA4BSMAT**	**Credits**	**0**	**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 concepts of linear algebra and numerical methods	1	–
CO2	**Apply** the concepts of integral calculus	1	–

UNIT – I

NUMERICAL METHODS – 1:
Elementary row transformation of a matrix, Rank of a matrix. Consistency and Solution of system of linear equations; Gauss-elimination method and Approximate solution by Gauss-Seidel method. Eigenvalues and Eigenvectors.

UNIT – II

NUMERICAL METHODS – 2:
Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson methods (only formulae). Problems.

Finite differences, Interpolation using Newton's forward and backward difference formulae and Lagrange's interpolation formula (without proof). Problems.

Numerical integration: Simpson's $(1/3)^{rd}$ and $(3/8)^{th}$ rules (without proof): Problems.

UNIT – III

NUMERICAL METHODS – 3:
Numerical Solution of Ordinary Differential Equations (ODE's):
Numerical solution of ordinary differential equations of first order and first degree: Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth-order, Milne's predictor-corrector formula (No derivations of formulae). Problems.

UNIT – IV

INTEGRAL CALCULUS:

Multiple Integrals: Evaluation of double integrals, evaluation of double integrals by change of order of integration, changing into polar coordinates. Evaluation of triple integrals. Problems.

UNIT – V

BETA-GAMMA FUNCTIONS AND VECTOR INTEGRATION:

Beta and Gamma functions: Definitions, properties, the relation between Beta and Gamma functions.

Vector Integration: Line integral, Green's theorem and Stokes' theorem.

Text Books:

1. "Higher Engineering Mathematics", B. S. Grewal, 44th edition, 2018, Khanna Publishers.
2. "Advanced Engineering Mathematics", Erwin Kreyszig, 10th edition (reprint), 2016, John Wiley & Sons.

Reference Books:

1. "Higher Engineering Mathematics", B. V. Ramana, 11th Edition, 2007, McGraw-Hill Education.
2. "Engineering Mathematics", Srimanta Pal and Subodh C. Bhunia, 3rd reprint, 2016, Oxford University Press.
3. "A Textbook of Engineering Mathematics", N. P. Bali and Manish Goyal, Laxmi Publications.
4. "Advanced Engineering Mathematics", C. Ray Wylie and Louis C. Barrett, 6th edition, McGraw-Hill Book Company, New York.
5. "Engineering Mathematics for Semester I and II", Gupta C. B., Sing S. R. and Mukesh Kumar, 2015, McGraw-Hill Education (India).
6. "Higher Engineering Mathematics", H. K. Dass and Er. Rajnish Verma, 2014, S. Chand Publication.
7. "Calculus", James Stewart, 7th edition, 4th reprint, 2019, Cengage Publications.

E-Books and Online Course Material:

1. `http://nptel.ac.in/courses.php?disciplineID=111`
2. `http://www.class-central.com/subject/math` (MOOCs)
3. `http://academicearth.org/`
4. VTU e-Shikshana Program
5. VTU EDUSAT Program

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Course Title	**FUNCTIONAL ENGLISH** (For lateral entry students)				
Course Code	**23MA3HSENG / 23MA4HSENG**	**Credits**	**0**	**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	**Communicate** effectively and creatively in both non-verbal and verbal forms in various multi-disciplinary activities.	10	–
CO2	**Upgrade** organizational skills/traits, team spirit/working in liaison and thus boost professional etiquette and ethics.	9, 10	–
CO3	**Write** effective technical reports, dissertation and project documents and make effective oral and written presentations.	9, 10	–
CO4	**Enhance** employability via training in writing correct and effective Applications/Resumes.	10	–
CO5	**Perform** well against Domestic and International Industry Standards via group discussions and Power Point Presentations.	9, 10	–
CO6	**Strengthen** basic grammar components/structures and overcome mistakes/wrong pronunciation and thereby, encourage speaking/writing in flawless English.	10	–

UNIT – I

COMMUNICATION:

- Introduction – Role and Importance of English in the Corporate World.
- Communication – Importance of technical communication-levels, flow of organizational communication
- Effective Presentation strategies: non-verbal communication aspects, Preparing Power Point Presentation
- Public Speaking
- Listening –Types, traits and importance of listening

- Telephone Etiquette
- Interviews-types and preparation.
- Interpersonal Communication Skills –Group Discussion

Additional Reference:

- Communication: Organizational communication, Communication cycle, Barriers
- Language as a tool of communication, characteristics of language
- Non-verbal communication
- Power point presentations
- Traits of a good listener, barriers
- Interviews: questions frequently asked
- Business Meetings/Conferences: Spoken
- Effective reading skills

UNIT – II

Technical Writing / Speaking: Specific Focus:

- Letter Writing – Job Applications, E-mails and other Official Letters
- Writing a résumé
- Writing reports and dissertation / thesis-structure and significance
- Description of Graphics – kinds, construction, use and application (in scientific texts) and Interpretation

Additional Reference:

- Paragraph Writing, Expansion of ideas – Précis Writing
- Business Letters: Significance, purpose, structure, layout, types and samples
- Curriculum Vitae / résumé / bio-data–different formats
- Technical Reports: objectives, characteristics and categories
- Manuscript format, prefatory parts and main text
- Interpretation of the diagrams and graphs in paragraphs
- Structure of a Research dissertation/thesis.

UNIT – III

Grammar: Basics and Structures:

- Parts of Speech-in brief
- Transformation of Sentences, Active and Passive Voice, Direct and Indirect Speech.
- Subject-Verb Agreement

Additional Reference:

- Nouns, Pronouns, Tenses, Articles and Prepositions. Adjectives, Conjunctions, Adverbs, Interjection
- Degrees of comparison
- Punctuation
- Types of sentences
- Simple-compound and complex sentences

- Rules governing Active-Passive voice and Direct-Indirect Speech
- Singular and plural nouns and verbs.

UNIT – IV

Vocabulary:

- Correct pronunciation of important words
- Identifying errors in sentences – often mispronounced and misspelt words
- Difference between American and British English,
- Indianism – Mother tongue influence
- Using Idioms and phrases – words commonly misused and confused
- Analogy of Comparison
- Corporate/conventional idioms.

Additional Reference:

- IPA script chart to read sounds-vowels and consonants
- Spellings chart
- Words often mispronounced
- Homophones and homonyms
- American English – evolution, expressions and slangs
- How American English has influenced corporate world
- Indianized expressions in English
- Phrasal verbs and proverbs.

Text Books:

1. "Practice and Perfect" – a workbook issued by the Department of Mathematics and Humanities, B.M.S. College of Engineering.
2. Additional Reference Source prepared by the Faculty of English issued by the Department of Mathematics and Humanities, B.M.S. College of Engineering.

Reference Books:

1. "IELTS Preparation and Practice", Wendy Sahanaya and Terry Hughes, Oxford University Press, 2007.
2. "Technical Communication: Principles and Practice", Meenakshi Raman and Sangeetha Sharma.
3. "English for Presentations", Marion Grussendorf, Oxford Uuniversity Press, 2015.
4. "Making Sense of English", M.Yadugiri, Viva Publications.
5. "Advanced English Grammar", Thomson and Martinet, Cambridge University Press.

V Semester Syllabus

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Course Title	FUNDAMENTALS OF VLSI				
Course Code	23EC5PCFOV	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 and Digital System Design in the context of VLSI circuits and subsystems.	1	3
CO2	**Analyze** CMOS circuits and subsystems to obtain the desired performance parameters.	2, 5, 9, 10	3
CO3	**Design** CMOS based combinational and sequential circuits for given specifications.	3, 5, 9, 10	3

UNIT – I

MOS Transistor: Long Channel I-V characteristics, C-V Characteristics, Simple MOS Capacitance Models, Detailed MOS Gate Capacitance Model, Non ideal I-V Effects.

CMOS Logic: Inverter, NAND Gate, NOR Gate, CMOS Compound Gates. VLSI design flows.

UNIT – II

CMOS Processing Technology: CMOS Technologies, CMOS Inverter Fabrication and Layout, Layout Design Rules, Gate Layouts and Stick Diagrams. CMOS Process enhancements. Manufacturing Issues.

UNIT – III

Static CMOS Inverter: DC Characteristics, Beta Ratio Effect, Noise Margin, Pass Transistor DC Characteristics, Circuit design using Pass Transistors and Transmission Gates, Tristate buffer, Multiplexers.

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

UNIT – IV

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

Array Sub system: SRAM: SRAM Cells, Row Circuitry, Column Circuitry.

DRAM: Subarray Architectures, Column Circuitry, Embedded DRAM.

UNIT – V

Silicon Debug Principles, Manufacturing Test Principles: Fault Models, Observability, Controllability, Repeatability, Fault Coverage, ATPG, Delay Fault Testing, Design for Testability: Ad Hoc Testing, Scan Design, BIST, IDDQ Testing, Design for Manufacturability, Boundary Scan.

Text Books:

1. "CMOS VLSI Design: A Circuits and Systems Perspective", 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	MICROWAVE THEORY AND ANTENNA				
Course Code	23EC5PCMTA	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 concepts and properties of Electromagnetism to obtain parameters of microwave devices and antennas	1	1
CO2	Analyze different types of microwave devices and antennas for various applications	2	1
CO3	Present Case study / Seminar on Advanced topics on 3,5,9,10 microwave devices and Antenna Design as an individual/team	3, 5, 9, 10	1

UNIT – I

Introduction to Microwave Theory: Frequency Band, Applications, Merits and Demerits of Microwave Theory, Transmission Line Equations, Characteristic and Input impedances, Reflection and Transmission coefficients, Standing waves and SWR, Mismatch losses in Transmission lines.

UNIT – II

Microwave Network theory: Introduction to Microwave theory, S matrix representation of Multi-Port Networks, Symmetrical Z and Y-Parameters for reciprocal Networks.

Microwave Passive Devices: Waveguide multiport junctions - E plane and H plane Tees, Magic Tee, 2-hole Directional coupler, Isolator and Circulator.

UNIT – III

Fundamentals of Antennas: Principle of antenna, fields from oscillating dipole, antenna field zones, basic antenna parameters, patterns, beam area, Radiation intensity, beam efficiency, directivity and gain, antenna aperture, effective height and radio communication link (Friis formula).

UNIT – IV

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

Source and Arrays: Point source, Types of Arrays (Broad side, End fire, Extended End fire), pattern multiplication.

UNIT – V

Types of Antennas: Thin linear antenna, Yagi-Uda antenna, Horn antenna, parabolic reflectors, Micro strip rectangular patch antenna. Steps to design an antenna in a commercial industry standard software.

Textbooks:

1. "Microwave Engineering", Annapurna Das, Sisir K Das, 3rd Edition, McGraw-Hill, 2015.
2. "Radio Frequency and Microwave Electronics", Matthew M Radmanesh, Pearson, 2015.
3. "Antennas and Wave Propagation", John D Kraus, Ronald J Marhetka, Ahmad S Khan, 5th Edition, Tata McGraw Hill, 2017.

Reference Books:

1. "Antenna, Theory, Analysis & Design", Constantine A Balanis, 4th Edition, John Wiley & Sons, 2016.

Online Course Material:

1. https://onlinecourses.nptel.ac.in/noc20_ee91/preview
2. https://archive.nptel.ac.in/courses/108/101/108101112/
3. https://onlinecourses.nptel.ac.in/noc20_ee20/preview
4. https://onlinecourses.nptel.ac.in/noc22_ee63/preview
5. https://nptel.ac.in/courses/117107035

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

(Autonomous College under VTU)

Course Title	**DIGITAL SIGNAL PROCESSING**				
Course Code	**23EC5PCDSP**	**Credits**	**3**	**L – T – P**	**3:0:0**
CIE	**50 Marks (100% weightage)**		**SEE**	**100 Marks (50% weightage)**	

Prerequisites: Signals and systems

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

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	**Apply** the knowledge of signal processing to solve Engineering problems on Discrete Fourier Transform and Filters.	1	1
CO2	**Analyze** frequency domain characteristics of a signal and Filter performance for a given specification.	2	1
CO3	**Design** and realize Analog and Digital Filter algorithms.	3	1
CO4	**Use** modern tools to carry out analysis on Signals using Discrete Fourier Transform, and to simulate filters for chosen applications.	4, 5, 9, 10	1, 3

UNIT – I

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

Use of DFT in linear filtering, linear convolution of two finite duration sequences, overlap adds and save methods. Relation between DFT and other transforms. Direct computation of DFT. Necessity for efficient computation of DFT. Radix2 Fast Fourier Transform (FFT) algorithm for DFT computation. Decimation in time algorithm, decimation in frequency algorithms. Radix2FFT algorithm for computation of Inverse Discrete Fourier Transform (IDFT).

UNIT – III

Introduction to IIR filters, Pole zero placement method for simple IIR Filters, Impulse invariant & Bilinear Transformations, Design of analog Butterworth and Chebyshev filters, Design of Digital

Butterworth and Chebyshev filters. Introduction to realization of digital systems, Infinite Impulse Response (IIR) systems: parallel form, cascade form.

UNIT – IV

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 & Hamming windows. Realization of Finite Impulse Response (FIR) systems: Direct Form, Linear Phase Form.

UNIT – V

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.

Textbooks:

1. "Digital Signal Processing, Principles, Algorithms and Applications," John G. Proakis, Dimitris K Manolakis, Pearson education/PHI (4th Edition).
2. "Digital Signal Processing," Tarun Kumar Rawat, Oxford University Press (16 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, John R. Buck, Prentice-Hall Signal Processing Series, 2nd Edition, 1999.
3. "Understanding Digital Signal Processing," Richard G. Lyons, Prentice Hall, March 25, 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://nptel.ac.in/courses/117/102/117102060/

MOOCs:

1. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ee05/

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

(Autonomous College under VTU)

Course Title	DIGITAL COMMUNICATION THEORY				
Course Code	23EC5PCDCT	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Knowledge of Digital Signal Processing, Principles of communications systems

Course Outcomes:

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

Sl. No.	Course Outcomes	PO	PSO
CO1	**Apply** the knowledge of various signal processing and coding techniques for digital communication systems.	1	1
CO2	**Analyse** the performance and design constraints of techniques learnt in the digital communication system.	2	1
CO3	**Design** and analyse digital modulation, spread spectrum and coding for Optimum receivers.	3	1
CO4	Conduct hardware experiments and use modern tools to simulate experiments on digital texhniques used in DCS	4, 5, 9, 10	1

UNIT – I

Introduction to Block diagram of DCS with basic signal processing operations, Communication channel, Pulse code modulation, Uniform quantization and its SQNR, Robust quantization – A- and μ-law companding, Differential PCM TR and RX, 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.

UNIT – II

Optimum Receiver structures - correlator type receivers, Matched filter type receivers, Digital Modulations - Generation and detection of BASK, BPSK, and BFSK, Signal space constellations, Generation and detection of QPSK, waveforms and its Signal space constellation, Generation and detection of DPSK, waveforms, Probability of bit error expressions and Performance analysis of all the schemes in terms of probability of bit error, BW, and Power.

UNIT – III

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 DS SS and FHSS, Introduction to OFDM.

UNIT – IV

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

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 encoder representation, impulse response, transform domain representation, tree, trellis and state representation.

Textbooks:

1. "Digital Communications", Simon Haykin, John Wiley, 2003.
2. "Digital communications", Bernard Sklar, Pearson education, 2007.

Reference Books:

1. "Modern Analog and Digital Communications", Lathi and Ding, Oxford Press.
2. "Concepts of Information theory and coding", P. S. Satyanarayana, DYNARAM, 2005.

MOOCs:

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

LIST OF LABORATORY EXPERIMENTS

Sl. No.	Title of the Experiment
	PART A (Hardware Experiments)
1.	Generation and detection of BASK for given specifications
2.	Generation and detection of BFSK for given specifications
3.	Generation and detection of BPSK for given specifications
4.	Experimental Study of directivity, gain of microstrip dipole and Yagi uda patch antennas.
5.	Experimental Study of directivity, gain of array antenna.

Sl. No.	Title of the Experiment
PART B (Simulation Experiments on MATLAB/Python Platform)	
6.	Simulation of techniques learnt in MODULE 1 – PCM, DPCM
7.	Simulation of techniques learnt in MODULE II – Different Modulations
8.	Simulation of techniques learnt in MODULE III – Spread spectrum
9.	Simulation of techniques learnt in MODULE IV – Source coding
10.	Simulation of techniques learnt in MODULE V – Channel coding
11.	Simulation of end-to-end Communication system with BER plots (in AWGN)
12.	Simulation of OFDM
Part C (Demonstration Experiments)	
13.	Study of different modulations and demodulation on SDR platform
14.	Study of various optical losses in optical fiber communication

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

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Course Title	ENVIRONMENTAL STUDIES				
Course Code	23CV5HSEVS	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	Identify and discuss the components and impacts of human activities on environment, conservation and on protection of natural resources	1, 6, 7	–
CO2	Identify and establish relationship between social, economic and ethical values from environmental perspectives.	1, 6, 7	–

UNIT – I

Introduction to Environment: Definition, About the Earth: Atmosphere, Hydrosphere, Lithosphere and Biosphere, Structure of Atmosphere, Internal structure of the Earth Ecosystem, Balanced ecosystem, types of Ecosystem Effects of Human activities on Environment. Environmental Impact Assessment (EIA).

UNIT – II

Natural Resources: Water resources, its availability, Mineral resources, Forest resources.

UNIT – III

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 sources of energy.

UNIT – IV

Environmental pollution: Effects and control of pollutions i). Water pollution, ii). Land pollution, iii).Noise pollution.

UNIT – V

Current environmental issues & importance: Population growth effects & Control, Climatic changes, Global warming. Acid rain Ozone layer depletion & effects, Environmental protection; Role of Government, initiatives by Non-Govt. Organizations.

Text Books:

1. Dr. Geetha Balakrishanan and K. G. Lakshminarayana Bhatta, “Environmental studies”, S M Publications, 5th Edition, 2017.
2. N. S. Subramanyam and A.V.S.S. Sambamurthy, “Ecology”, Alpha Science International Ltd, 2nd Edition, 2006.
3. Dr. J. P. Sharma, “Environmental studies”, Laxmi Publications, Third Edition, 2009.
4. Smriti Srivastava, “Environment and Ecology”, S K Kataria & Sons, 2023.

Reference Books:

1. Benny Joseph, “Environmental Studies”, Mc Graw Hill Education, 3rd Edition, 2017.
2. Dr. D. L. Manjunath, “Environmental Studies”, Pearson Education India, 3rd Impression, 2009.

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(Autonomous College under VTU)

Course Title	IMAGE PROCESSING				
Course Code	23EC5PE1IP	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 images in various data formats by applying image transformation or processing techniques for different applications.	4	1

UNIT – I

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 – Neighbors 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

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

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

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

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.

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 and Online Course Materials:

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 will be supplemented by practical experimentation in a simulator environment for clear understanding.

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Course Title	SATELLITE COMMUNICATION				
Course Code	23EC5PE1SC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Communication Theory, 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 mathematics and communication principles to Satellite communication.	1	1
CO2	**Analyze** the performance of various Satellite sub-systems for given parameters.	2	1
CO3	**Design** the satellite subsystems for the given specifications.	3	1

UNIT – I

SATELLITE ORBITS: Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geostationary and non-geostationary orbits – Look Angle Determination, Limits of visibility, eclipse-Sub-satellite point – Sun transit outage-Launching Procedures - launch vehicles and propulsion.

UNIT – II

SPACE SEGMENT: Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command-Transponders-The Antenna Subsystem.

UNIT – III

SATELLITE LINK DESIGN: Basic link analysis, Interference analysis, Rain-induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.

UNIT – IV

MODULATION AND MULTIPLEXING: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, DAMA Assignment Methods, compression – encryption, Coding Schemes.

UNIT – V

SATELLITE APPLICATIONS: INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. GPS Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS/DTH).

Text Books:

1. Dennis Roddy, "Satellite Communication", 4th Edition, McGraw Hill International, 2006.
2. Timothy Pratt, Charles Bostain and Jeremy Allnutt, "Satellite Communication", 2nd Edition, Wiley Publications, 2002.

Reference Books:

1. Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/Pearson, 2007.
2. N. Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986.
3. Bruce R. Elbert, "The Satellite Communication Applications Handbook", Artech House, Boston, London, 1997.
4. Tri T. Ha, "Digital Satellite Communication", 2nd edition, 1990.
5. Emanuel Fthenakis, "Manual of Satellite Communications", McGraw Hill Book Co., 1984.
6. Robert G. Winch, "Telecommunication Transmission Systems", McGraw-Hill Book Co., 1983.
7. Brian Ackroyd, "World Satellite Communication and Earth Station Design", BSP professional Books, 1990.
8. G.B. Bleazard, "Introducing Satellite Communications", NCC Publication, 1985.
9. M. Richharia, "Satellite Communication Systems - Design Principles", Macmillan, 2003.

E-Books:

1. `https://pce-fet.com/common/library/books/31/711_%5BLouis_J._Ippolito_Jr.%5D_Satellite_Communications_S(b-ok.org).pdf`

MOOCs:

1. `https://www.coursera.org/courses?query=satellite`

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

(Autonomous College under VTU)

Course Title	INTRODUCTION TO AI				
Course Code	23EC5PE1AI	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Knowledge of Calculus and Probability & Statistics

Course Outcomes:

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

Sl. No.	Course Outcomes	PO	PSO
CO1	**Understand** the difference between cognitive and artificial intelligence	–	–
CO2	**Apply** the characteristics and architectures of various expert systems that differentiate it from the conventional systems.	1	2
CO3	**Analyze** knowledge of genetic algorithms and swarm intelligence with their principles and procedures.	2	2

UNIT – I

Artificial Intelligence: History and Applications

Introduction, Intelligence, Artificial Intelligence, Progress of Artificial Intelligence, Modeling, Simulation and AI, Intelligent Systems.

UNIT – II

Artificial Intelligence as Representation and Search

The Predicate Calculus: Introduction, the propositional Calculus, the predicate calculus, Using Inference rules to produce predicate calculus expressions, Application: A logic-based financial Advisor.

Structure and Strategies for State Space Search: Introduction, Graph Theory, Strategies for State Space Search, Using the state space to represent reasoning with predicate calculus.

UNIT – III

Heuristic Search and Stochastic Methods

Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, the best fit search algorithm, admissibility, monotonicity, and Informedness, Using Heuristics in Games, Complexity Issues.

Stochastic Methods: Introduction, the elements of counting, elements of probability theory, applications of stochastic methodology, Bayes theorem, Recursion-based search.

UNIT – IV

Expert Systems

Introduction, expert systems, features, Characteristics, Architecture, Basic Activities, Advantages, Difference between Expert systems and conventional methods.

Stages in development of an expert system, Building of a rule-based expert system, Machine learning expert system, Probability based expert system.

UNIT – V

Introduction to Genetic Algorithm and Swarm Intelligence

Introduction, Genetic Algorithms, Procedure of Genetic Algorithms.

Introduction to swarm intelligence, Importance of ant colony paradigm, Ant colony systems, Development of ant colony system.

Text Books:

1. "Artificial Intelligence, Structures and Strategies for Complex Problem Solving", George F Luger, Fifth edition, Pearson Education.
2. "Artificial Intelligence and Intelligent Systems", N P Padhy, 2017, Oxford Publication.

Reference Books:

1. "Artificial Intelligence - A Modern Approach", Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2014.
2. "Introduction to Artificial Intelligence and Expert Systems", Dan W Patterson, Pearson, 2015.

E Books:

1. https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf
2. https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf

MOOCs:

1. https://onlinecourses.nptel.ac.in/noc23_cs92/preview

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

(Autonomous College under VTU)

Course Title	ADVANCED DIGITAL LOGIC DESIGN				
Course Code	23EC5PE1AD	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Fundamentals of VLSI and Concepts of Digital System Design using Verilog

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 System design to create digital building blocks using Verilog.	1	3
CO2	**Analyze** the RTL for timing violations and Synthesize the RTL to generate gate-level netlist.	2	3
CO3	**Design** RTL using basic building blocks along with design optimizations.	3, 5	3

UNIT – I

Logic Design and Challenges in VLSI Industry: 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. Expressions, Operators, Operands, Arrays, memories, Strings, Delays, parameterized designs. Procedural blocks, Blocking and Non-Blocking Assignment, looping, flow Control, Task, Function. Basic test bench generation and Simulation, Verilog modeling of combinational and sequential logic.

UNIT – II

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

RTL Timing Concepts: 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.

UNIT – IV

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

Design of Architectural building blocks using FSMs and Clock Domain Crossing: FSM Design – overlapping and non-overlapping Mealy and Moore state machine design. Clock Domain Crossing design techniques.

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, Sapan Garg, 2011.
6. Cliff Cummings: White paper (Clock Domain Crossing)

Reference Websites:

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

Online material:

1. Seer Academy recordings

E-Books:

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

MOOCs:

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

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

(Autonomous College under VTU)

Course Title	INFORMATION THEORY FOR CYBER-SECURITY				
Course Code	23EC5PE1IC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: None.

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 Information security concepts to demonstrate the techniques for Information security, Information Security Policies, Standards and Indian Cyber Law.	1	1, 2
CO2	Analyse the encryption algorithms for their strengths and weaknesses.	2	1, 2
CO3	Design and Implement basic algorithms in cryptography which is ultimately used in developing a secure information system.	3	1, 2
CO4	Involve in Independent learning on contemporary issues in Information Security System, Cyber security and its mechanisms, communicate effectively and prepare a report.	5, 9, 10	1, 2

UNIT – I

Introduction to Information System: Introduction, Types, Developments of Information Systems, Introduction to information Security, Need for Information Security, Threats to Information Systems, Information Assurance.

UNIT – II

Developing Secure Information System: Secure Information System Development, Application Development Security, Information Security Governance and Risk Management, Security Architecture and Design, Security Issues in Hardware, Data Storage and Downloadable Devices, Physical Security of IT Assets, Backup Security Measures.

UNIT – III

Information Security Policies, Standards and Cyber Law: Security Policies, Policy Review Process, Information Security Standards, Cyber Law in India, Intellectual Property Law, Semiconductor Law, Software Licenses.

UNIT – IV

Cyber Security, Classification, Tools and Methods Used in Cyber Crime: Introduction to Cyber Security, Cyber Security Risk Analysis, Classifications of Cybercrimes, how Criminals Plan Them: How Criminals Plan the Attacks, Cyber Stalking, Botnets. Proxy, Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Trojan Horses and Backdoors, SQL Injection, Buffer Overflow.

UNIT – V

Cybercrimes and Cybersecurity: The Legal Perspectives Introduction, Cybercrime and the Legal Landscape around the world, need for Cyber laws (Indian Context), Indian IT Act, Challenges to Indian Law and Cybercrime Scenario in India, Consequences of not addressing the weakness in the IT ACT, Digital Signatures and the Indian IT Act, Amendments to the Indian IT Act, Cyber-crime and Punishment.

Text Books:

1. "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Nina Godbole & Sunit Belapure.
2. "Cryptography and Network Security Principles and Practice", William Stallings, Pearson.
3. "Cyber Security", Dr. Krishan Kumar Goyal and Prof. Amith Garg, University Science Press.

Reference Books:

1. "Security in Computing, Fourth Edition", Charles P. Pfleeger, Pearson Education.
2. "Modern Cryptography: Theory and Practice", Wenbo Mao, Prentice Hall.
3. "Network Security Essentials: Applications and Standards", William Stallings, Prentice Hall.

E-Books:

1. https://wcu.edu.az/uploads/files/Cyber%20Security%20Essentials%20(%20PDFDrive%20).pdf
2. https://library.iiitd.edu.in/cgi-bin/koha/opac-detail.pl?biblionumber=174182

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

(Autonomous College under VTU)

Course Title	INTRODUCTION TO AR/VR				
Course Code	23EC5PE1VR	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: None

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

Sl. No.	Course Outcomes	PO	PSO
CO1	**Understand** the basics of Virtual Reality and the technology involved.	–	–
CO2	**Apply** the potential factors involved in implementing concepts of Virtual Reality.	1	1
CO3	**Analyse** VR Hardware and Software implementation and factors involved in rendering the process.	2	1

UNIT – I

Introduction, Fundamentals of Virtual Reality: What is Virtual Reality?, Virtual Reality as an Immersive Technology, Reality-Virtuality Continuum, Working Principle, Uses and Benefits, History of Virtual Reality, Application Domains.

UNIT – II

Virtual Reality Hardware and Software: Introduction, Field of View, Degrees of Freedom, Stereoscopy, Hardware: Input Devices, Output Devices, Virtual Reality Displays, Tracking - Magnetic, Electromagnetic, Ultrasonic, and Inertial, and Optical. Software: Platforms – Development and Deployment, VR Scripting, VRML, X3D, Web VR.

UNIT – III

Creating a Virtual Reality Experience Design: Illusions of Presence, Perceptual Modalities.

Health Effect: Motion Sickness, Eye Strain, Seizures, After-effects, Factors Affecting Health.

Design Guidelines: Hardware, System Calibration, Latency Reduction, General Design, Motion Design, Interaction Design, Usage, Measuring Sickness.

UNIT – IV

Factors involved in Implementation of VR-Rendering: Virtual Environments, Object Modeling, Geometric Transformation, Perspective Views, 3D Clipping, Stereoscopic Vision, Rendering, Texture Mapping, 360 degree Images and Videos.

Wayfinding – Landmark, Signs and Maps. Interaction: Interacting with Virtual Objects, Direct and Indirect Interactions, Modes of Interactions.

UNIT – V

VR used for Training Industry Case Studies: Transforming radiography training, VR for employees to practice presentation skills, Reality-based welding simulator: Significance, virtual training, and industrial correlation.

Text Books:

1. "The VR Book: Human-Centered Design for Virtual Reality", Jason Jerald (ACM Books).
2. "Understanding Augmented Reality, Concepts and Applications", Alan B. Craig, Morgan Kaufmann, 2013.

Reference Books:

1. Burdea, G. C. and P. Coffet., "Virtual Reality Technology", Second Edition, Wiley-IEEE Press, 2003/2006.

E-Books and Online Course Material:

1. `https://www.queppelin.com/ebooks/`

MOOCs:

1. `https://www.coursera.org/learn/introduction-virtual-reality`

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

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Course Title	OPERATING SYSTEMS				
Course Code	23EC5PE1OS	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 for system security and protection.	1	2
CO2	Analyze process scheduling, synchronization, memory management and I/O management of operating systems.	1, 2	2
CO3	Present a case study on the advanced features of modern operating systems.	5, 9, 10	2

UNIT – I

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

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, Processes and Threads creation in Linux with Programming.

UNIT – III

Process Synchronization: Race conditions, Critical sections, Control Synchronization and Indivisible operations, Deadlock condition, Process Synchronization Scheduling: Scheduling Concepts, Non-preemptive and Preemptive Scheduling Policies, Real-Time Scheduling: EDF, RMS, Program Examples.

UNIT – IV

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

File System and I/O Management: Overview of file processing, Files and file operations, Interface between file systems and IOCS, Layers of Input-output control system, Overview of IO organization, I/O devices, Device level I/O.

Text Books:

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

Reference Books:

1. "Operating Systems Concepts" by Silberschatz and Galvin, John Wiley, 7th Edition, 2001.
2. "Operating System – Internals and Design Systems" by 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`

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Course Title	IOT AND ITS APPLICATIONS				
Course Code	23EC5PE1IT	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 and C++, and Python (can pick up during the course)
- Networking concepts and technologies

Objectives of the course:

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of various IoT aspects (sensors, actuators, processing, technologies) and characteristics to evolve solutions related to applications and architectures.	1	1, 2
CO2	Analyze, compare, and Identify Technologies, Protocols (including adaptations), Analytic Techniques, and review Risk Management methods.	2	1, 2
CO3	Design Solutions encompassing systems, hardware, and software aspects for various categories of problems with IoT in context.	3	1, 2
CO4	Research various domains of IoT application and provide analysis, interpret data where available, and provide recommendations.	4, 6, 9, 10	1, 2

UNIT – I

Fundamentals of IoT: What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact: Connected Roadways, Connected Factories, Connected Buildings, IoT Challenges, IoT Network Architecture and Design, A simplified IOT Architecture, Core IOT Functional Stack, Data Management and Compute Stack, Smart Objects: The “Things” in IoT, Sensors, Actuators, and Smart Objects.

UNIT – II

IoT Protocols: Sensor Networks, WSNs, Communication Protocols for WSNs, Connecting Smart Objects, Communications Criteria, IoT Access Technologies with considerations of layers, topology, and security, competitive technologies: IEEE 802.15.4, IEEE 802.15.4g, IEEE 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN and competitive technologies, NB-IoT, other LTE variations, and competitive technologies.

UNIT – III

IP and Application Protocols: 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: Supervisory Control and Data Acquisition System (SCADA), Common Object Access Protocol (CoAP), Message Queuing and Telemetry Transport (MQTT).

UNIT – IV

Design and Development: IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints - Raspberry Pi: Introduction to Raspberry Pi, About the Raspberry Pi Board: Hardware Layout, Operating Systems on Raspberry Pi, Configuring Raspberry Pi, Programming Raspberry Pi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to Raspberry Pi.

UNIT – V

Applications: Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples. Transportation and Transports, Transportation Challenges, IoT Use Cases for Transportation (Connected Cars, Connected Fleets, Infrastructure and Mass Transit), An IoT Architecture for Transportation.

Text Books:

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

Reference Books:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, 1st Edition, VPT, 2014. (ISBN: 978-8173719547).
2. Raj Kamal, “Internet of Things: Architecture and Design Principles”, 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-of-Things%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 can be supplemented by project-based learning.

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Course Title	OBJECT ORIENTED PROGRAMMING USING C++				
Course Code	23EC5PE1OP	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Logical thinking, Basic Programming Skills, C programming

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

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

UNIT – I

Migration from C to C++ – Shortcomings of C and need for object-oriented programming, reference variables, structures, enum with their importance, manipulators, macros, functions – pass by: value, address, and reference, importance of default values in creating applications.

UNIT – II

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

Operator overloading: Overloading unary and binary operators, overloading using friend functions and its usage, rules for overloading. Inheritance: Single and multiple inheritances, public, private and protected inheritance. Pointers to objects, this pointer, pointers to derived classes, virtual functions, run-time polymorphism.

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.

UNIT – IV

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

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.

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.

E-Books:

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

Online Resources:

1. `https://www.w3schools.com/cpp/cpp_oop.asp`
2. `https://www.geeksforgeeks.org/object-oriented-programming-in-cpp/`
3. Video lectures on BMSCE Studio.

MOOCs:

1. `https://www.mooc-list.com/course/object-oriented-programming-edx`

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

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Course Title	PROJECT MANAGEMENT AND FINANCE				
Course Code	23ES5HSPMF	Credits	2	L – T – P	2:0:0
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	–
CO2	Implement project management methodologies ethically for successful project completion	2, 8, 9	–
CO3	Identify the investment opportunities and to formulate the projects	11	–
CO4	Choose projects which benefit the society and organization and apply project phases and document them for future reference	6, 10, 12	–

UNIT – I

Concepts of Project Management: Concepts of project, Categories of project, Project life cycle phases, Project management concepts, Tools and techniques for project management, The project manager, Need, Roles and responsibilities of project manager. Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects.

UNIT – II

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, Fixing the Zero date.

UNIT – III

Organizing Human Resources and Contracting: Delegation, Project manager's authority, Project organization, Contract, Contract Planning, Tendering and Selection of Contractor, Team building.

UNIT – IV

Organizing Systems and Procedures for Project Implementation: Working of Systems, Work break down structure, Planning, Scheduling and Monitoring, Critical Path Method, Gantt Chart/Time Chart, PERT, Project diary.

UNIT – V

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.

Text Books:

1. "Project Management", S Choudhury, Tata McGRAW Hill Publishing Company Limited.
2. "Project Planning, Analysis, Selection, Financing, Implementation and Review", Dr. Prasanna Chandra McGRAW Hill Publishing Company Limited.
3. "Project Management Institute: A Guide to the Project Management Body of Knowledge", PMBOK Guide (Sixth 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 Maylor, Pearson Publication.

E-Books:

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

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Course Title	**MINI PROJECT**				
Course Code	**23EC5PWMPR**	**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	Formulate the research problem by synthesizing insights from a comprehensive literature review.	1, 2, 4	1, 2, 3
CO2	Investigate contemporary tools for project implementation.	5	1, 2, 3
CO3	Ability to produce a thorough report outlining the project and its outcomes, with the potential for publication.	3, 6, 7	1, 2, 3
CO4	Make effective communication by presentation of the work as an individual or a member of a team.	8, 9, 10, 11	1, 2, 3
CO5	Develop sustainable system with scope for enhancement and continue life-long learning.	12	1, 2, 3

VI Semester Syllabus

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Course Title	WIRELESS COMMUNICATIONS AND NETWORKS				
Course Code	23EC6PCWCN	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	POs	PSOs
CO1	Acquire the Knowledge of Architecture, Techniques and algorithms in wireless communication systems	-	-
CO2	Apply the knowledge of cellular concepts, propagation mechanisms to the wireless communication and networks	1	1
CO3	Analyze the propagation models and Call flow scenarios in various mobile networks.	2, 5	1

UNIT – I

Introduction to Wireless Communication System, Introduction to wireless networks-Wi-Fi, Blue tooth, Mobile IP.

Multiple access schemes-FDMA, TDMA and CDMA, Overview of 2G GSM System Architecture, GSM Call flow and handover in GSM.

UNIT – II

Cellular concepts: Frequency reuse, channel assignment strategies, handoff, interference and system capacity, power control. Improving capacity in cellular system, Radio network Coverage planning (case study).

UNIT – III

Mobile Radio propagation: Introduction to radio wave propagation, the three basic mechanism-Reflection, Diffraction, Scattering, shadowing, fading and refraction.

Propagation Models: Free Space Propagation Model, Okumura Hata Model, Walfisch Ikegami Model, Knife Edge Model, Ray Tracing Model (qualitative analysis only), Link Budget calculations (case study).

UNIT – IV

Long Term Evolution (4G): Introduction to Long Term Evolution (4G)- LTE Architecture, Radio Spectrum, Frame Structure, Resource Blocks, OFDMA Principle with block diagram, Physical channels, UL Transmission, DL transmission.

UNIT – V

5G Mobile Technology: Introduction, 5G applications and requirements,5G use Cases and System Concept, 5G architecture, 5G Spectrum, 5G Enabling Technologies - Device to Device and Machine to Machine communication, mm-wave communications, massive MIMO, Multi RAT, Carrier aggregation, relaying, Small cell networks (only concepts).

Text Books:

1. "Wireless Communication Principles and Practice", Theodore S Rappaport, PHI, 2002.
2. "LTE:From Theory to Practice", Stefania Sesia and Issam Toufik, Second Edition, Wiley, 2011.
3. "5G Mobile and Wireless Communication Technology", Afif Osseiran and Jose F Monserrat, Cambridge University Press, 2016.

Reference Books:

1. "Wireless Communications and Networks: Principles and Practice", William Stallings, Second Edition, Pearson.

E-Books:

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

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
3. Wireless Communications by Dr. Ranjan Bose, Department of Electrical Engineering, IIT Delhi. (NPTEL lectures)

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Course Title	COMPUTER COMMUNICATION NETWORKS				
Course Code	23EC6PCCCN	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	Apply the knowledge of networking and concepts of TCP/IP protocol stack to deliver packets across Multiple Networks (links).	1	2
CO2	Analyze the issues of routing and congestion mechanism for independent and internetworking networks for wired and wireless links.	2	2
CO3	Design, calculate, and apply subnet masks and routing addresses to fulfill networking requirements.	3	2
CO4	Create Network for given specification and conduct experiments within a simulated networking environment.	4, 5	2
CO5	Involve in independent learning on contemporary issues in networking technologies, communicate effectively and prepare a report.	7, 9, 10, 12	2

UNIT – I

Introduction to Data Communication, Networks, Protocols and Standards, Network Models, TCP/IP Protocol Suite: Layered Architecture, Layers in TCP/IP suite, The OSI Model: OSI Versus TCP/IP, Transmission Media, Switching, Telephone Network and Digital Subscriber Line Cable TV Network, Cable TV for data transmission.

UNIT – II

Data Link Layer: Data link Control-Framing, Flow and Error Control, Protocols: Stop and Wait Protocol, Go-Back-N Protocol, Selective Repeat Protocol. HDLC, PPP Protocol, Error detection and correction: Cyclic Codes and Check Sum.

UNIT – III

Medium Access: Random Access: ALOHA, CSMA, CSMA/CD, CSMA/ CA, Controlled Access, Channelization, Wired LANs:Ethernet Protocol, Standard Ethernet. Introduction to wireless LAN: Architectural Comparison, Characteristics, Access Control, Connecting devices, backbone networks and Virtual LANS.

UNIT – IV

Network Layer: Logical Addressing, Internet Protocol, Address Mapping, Packet Switching:Datagram Approach, Virtual Circuit Approach, IPV4 Addresses: Address Space, Classful Addressing, Classless Addressing Delivery, Forwarding and Routing, Unicast Routing: Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing. Multicast Distance Vector Routing.

UNIT – V

Transport layer: Services, Connectionless and Connection oriented Protocols, User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram, Windows in TCP, Flow control, Error control, Congestion control and Quality of Service.

Text Books:

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

Reference Books:

1. "Computer Networks", James F. Kurose, 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 Wesley.
4. "Introduction to Data Communications and Networking", Wayne Tomasi, Pearson.
5. "Computer Networks", A.S. Tanenbaum, PHI.

E-Books:

1. https://www.phindia.com/Books/BookDetail/9788120349070/data-communications-and-computer-networks-singh
2. https://www.phindia.com/Books/BookDetail/9788120348646/data-communications-and-computer-networks-gupta

Online Resources:

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

LIST OF LABORATORY EXPERIMENTS

Part-A – Programming in C/C++

1. Write a program to demonstrate Framing (Bit and Byte stuffing & destuffing).
2. Write a program to generate CRC code for checking error.
3. To study the Basic Networking Commands on Command Prompt: arp, ipconfig, hostname, tracert, route, ping etc.
4. Write a program to simulate Shortest Path Routing Algorithm using i) Dijkstra's Algorithm ii) Distance Vector Routing Algorithm.
5. Write a program to demonstrate Stop and Wait Protocol and Sliding Window Protocol.
6. Write a program for congestion control using leaky bucket algorithm.
7. Write a program to encrypt and decrypt a given message using substitution cypher method.

Part-B – Tool: Qualnet V9.3

8. Create a Network and analyze the performance of a Network for different topologies and compare performance of the Network for Varying Network Size and topology/traffic change.
9. Configure and Analyze the throughput, packet delivery for an Ethernet LAN.
10. Construct a point to point network and determine the packets dropped in Network and Comment on its Performance.
11. Apply a multicast protocol and analyze the performance of Network for a Multicast traffic scenario. Compare Multicast and Multiple unicast traffic.
12. Simulate and Analyze the performance of Wireless Ad hoc Network for Stationary and Mobile Nodes.
13. Model a LAN Network connected by a Switch and Analyze the Subnet Performance.
14. Configure a router to connect two subnets and analyze the performance of Connecting Device.
15. Compare the performance of RIP and OSPF Routing Algorithms and analyze packet delivery, end to end delay and throughput.
16. Simulate and Analyze wireless infrastructure network.
17. Scrutiny of Traffic between wired and wireless network.

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Course Title	MIXED SIGNAL DESIGN				
Course Code	23EC6PCMSD	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	3
CO2	**Analyze** circuits featuring CMOS-based amplifiers, as well as Analog-to-Digital Converters (ADC) and Digital-to-Analog Converters (DAC) and obtain the respective performance parameters.	2	3
CO3	**Design** analog CMOS integrated circuits and mixed signal circuits	3	3
CO4	**Conduct** experiments on Analog and mixed signal CMOS circuits using modern EDA tools	4, 5, 9, 10	3

UNIT – I

Review of Common-Source Stage and Source Follower, Cascode Stage.

Differential Amplifiers: Basic Differential Pair: Qualitative Analysis, Quantitative Analysis, Common-Mode Response, Differential Pair with MOS loads.

UNIT – II

Basic Current Mirrors, Cascode Current Mirrors. Active Current Mirrors: Large-Signal and Small-Signal Analyses in Differential mode and Common-mode.

UNIT – III

Operational Amplifiers: General Considerations, One-Stage Op Amps, Two-Stage Op Amps, Gain Boosting.

UNIT – IV

Switched-Capacitor Circuits: General Considerations, Sampling Switches, Switched Capacitor Amplifier Design.

Sample-and-Hold Characteristics, Digital-to-Analog Converter specifications, Analog-to-Digital Converter specifications, Mixed-Signal layout issues.

UNIT – V

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

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

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
2. https://github.com/bmurmann/Book-on-MOS-stages/raw/main/book/Analysis%20and%20Design%20of%20Elementary%20MOS%20Amplifier%20Stages.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.	Plot the V-I Characteristics of NMOS and PMOS transistors (I_D versus V_{GS} and I_D versus V_{DS}).
2.	Draw the schematic of a CMOS inverter and obtain the DC characteristics. Also perform the transient analysis.
3.	Connect three inverters back to back to make a ring oscillator. Find the period of oscillation and determine the delay of the inverter.
4.	Draw the layout of CMOS inverter and verify DRC, LVS. Determine the impact of RC extraction on the delay of inverter.
5.	Simulate basic and cascode current mirrors.
6.	Common Source amplifier with resistor and MOS loads: Transient, DC and AC analyses
7.	Source follower: Transient, DC and AC analyses
8.	Differential Input, Single-ended output operational transconductance amplifier (OTA): Transient, DC and AC analyses. Find the CMRR.
9.	Fully Differential amplifier: Transient, DC and AC analyses. Find the CMRR.
10.	2-stage OpAmp: Transient, DC and AC analyses. Find the CMRR.
11.	Design R-2R ladder DAC using the OpAmp designed above and measure the DNL and INL of the DAC.
12.	One open-ended experiment

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Course Title	COMPUTER VISION				
Course Code	23EC6PE2CV	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, the student will have the ability to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply various segmentation, feature extraction, and representation techniques for a given pattern analysis problem.	1	1, 3
CO2	Analyze basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.	2	1, 3
CO3	Design 3D visualization models to process 3D objects for a specific visualization task.	3	1, 3

UNIT – I

Pattern Analysis: Clustering: K-Means, Classification: Discriminant Function, Supervised, Unsupervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models. Comparison of all three models for best classifiers with examples.

UNIT – II

Feature extraction: Edges detection techniques- Canny, LOG, DOG and comparison study; Line detectors (Hough Transform), Corner detectors Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH.

UNIT – III

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

UNIT – IV

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

Modern Trends: Health care and security Biometrics – fingerprint, face, iris, digital signature; super resolution, Introduction to Augmented Reality , mixed reality, virtual reality and autonomous vehicles.

Text Books:

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

Reference Books:

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

E-Books:

1. http://szeliski.org/Book/drafts/SzeliskiBook_20100903_draft.pdf
2. https://www.amazon.in/Computer-Vision-Image-Processing-Virender-ebook/dp/B01GBMS78W

MOOCs:

1. https://www.coursera.org/courses?query=computer%20vision
2. https://www.classcentral.com/subject/computer-vision
3. https://www.edx.org/course/computer-vision-and-image-analysis-2
4. https://digitaldefynd.com/best-computer-vision-courses/

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Course Title	RADAR SYSTEM				
Course Code	23EC6PE2RS	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Communication Theory and Signals & Systems

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 communication principles to compute the parameters of the Radar system.	1	1
CO2	Analyze the performance of different types of Radar subsystems for given applications/specifications.	2	1
CO3	Design the Radar subsystems for a given set of specifications.	3	1

UNIT – I

Basics of Radar, Simple form of Radar Equation, Signal to Noise Ratio, Envelope Detector, Radar Cross Section of Targets, Transmitter Power, Pulse repetition frequency and Range Ambiguities, System Losses.

UNIT – II

CW and Frequency Modulated Radar: Doppler Effect, CW Radar, FM-CW Radar, Airborne Doppler Navigation, Multiple-Frequency CW Radar.

UNIT – III

MTI and Pulse Doppler Radar: Delay line cancellers, Pulse Doppler RADAR, Tracking Radar: Tracking with Radar, Sequential Lobbing Mono Pulse Tracking RADAR, Matched Filter Receiver, correlation detection, Detector characteristics, Radar Receivers, Phased Array Antennas.

UNIT – IV

Detection of Radar Signals in Noise: Matched Filter Receivers, correlation detection, Detection Criteria and Detector characteristics, Performance of the Radar Operator, Automatic Detection.

UNIT – V

Stealth Technology: Introduction, Principles, Stealth Technology for Application to Military aircraft, counters to Stealth: Bi Static RADARS, Advanced IR Detectors.

Text Books:

1. Merrill I. Skolnik, "Introduction to Radar Systems", TMH Special Indian Edition, 2nd Edition, 2007.
2. Vivek Kapur, "Stealth Technology and its effect on Aerial Warfare", Institute for Defence Studies and Analyses (IDSA), New Delhi.

Reference Books:

1. Merrill I. Skolnik, "Introduction to Radar Systems", 3rd Edition, Tata McGraw-Hill, 2001.
2. Byron Edde, "Radar Principals, Technology, Applications", Pearson Education, 2004.
3. Peyton Z. Peebles, Jr. "Radar Principles", John Wiley and Sons Inc., New York, 1998.
4. Emanuel Fthenakis, "Manual of Satellite Communications", McGraw Hill Book Co., 1984.
5. Robert G. Winch, "Telecommunication Transmission Systems", McGraw-Hill Book Co., 1983.
6. Brian Ackroyd, "World Satellite Communication and Earth Station Design", BSP professional Books, 1990.
7. G.B. Bleazard, "Introducing Satellite Communications", NCC Publication, 1985.
8. M. Richharia, "Satellite Communication Systems - Design Principles", Macmillan, 2003.

E-Resources:

1. IET Digital Library: Principles of Modern Radar: Basic principles (theiet.org) `https://www.phindia.com/Books/BookDetail/9788120348646/data-communications-and-computer-networks-gupta`
2. IET Digital Library: Radar Principles for the Non-Specialist (theiet.org)
3. The beginnings of stealth technology — IEEE Journals & Magazine — IEEE Xplore `https://doi.org/10.1109/7.259548`
4. Effect of Componential Camouflage on Aircraft's IR Multiband Susceptibility — IEEE Journals & Magazine — IEEE Xplore `https://doi.org/10.1109/TAES.2022.3200025`
5. "Principles and Techniques of Modern Radar Systems": Online Course Video Lectures, IIT Kharagpur (freevideolectures.com)
6. Simulation Tools: CST, HFSS

MOOCs:

1. `https://onlinecourses.nptel.ac.in/noc23_ee133/preview`

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Course Title	MACHINE LEARNING				
Course Code	23EC6PE2ML	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Knowledge of Linear Algebra, Calculus, Probability & Statistics and Basic Programming.

Course Outcomes:
At the end of the course, the student 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	1, 2
CO2	Analyze dataset features for different use cases and performance measures to evaluate the models.	2	1, 2
CO3	Design and develop application models using supervised and unsupervised machine learning algorithms.	3	1, 2

UNIT – I

Python for ML: Data types: list, tuple, dictionary; writing functions, conditional and looping statements, Python libraries for ML, Data Preprocessing: EDA using Numpy and Pandas, Data visualization with Matplotlib.
Introduction: Artificial intelligence & Machine Learning, ML Types: Supervised, Unsupervised, Semi-supervised and Reinforcement learning, Challenges of ML, Problems ML can solve.

UNIT – II

Regression: Simple & Multiple Linear regression, Gradient descent and regression model, Polynomial regression, regularization: L1 & L2, standardization and normalization, Model fitting, bias-variance trade off, Cross validation and performance evaluation, Evaluation Metrics: MAE, MSE, RMSE, RAE, RSE, R2-score, usecase & model building.

UNIT – III

Classification: kNN classifier- algorithm flow and distance measures, kNN variants: k-radius and kD tree, Support vector machine, Building classifier using kNN and SVC.
Decision tree: Construction of decision tree, node splitting criteria: gini, chi-square, entropy and

information gain; tree pruning and hyper-parameters, confusion matrix and classification report, AUC & ROC, Matplotlib annotations to visualize a tree, concept of ensembling, techniques: Bagging and Boosting, Random Forest.

UNIT – IV

Classifying with probabilistic models: Naive Baye's algorithm, Variants of Naïve Baye's, Logistic Regression Algorithms, logit and sigmoid functions, Training and testing the classifier model, Performance measures: Log loss, Jaccard Index & Accuracy score.

UNIT – V

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

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 & Sarah Guido, O'Reilly Publication, 2019.

Reference Books:

1. "Machine Learning", Tom M. Mitchell, McGraw-Hill Edition 1, 2013.
2. "Machine Learning in Action", Peter Harrington, dreamtech press Indian Edition, 2017.
3. "Hands-on Machine Learning with ScikitLearn & Tensorflow", Aurélien Géron, O'Reilly Publication, 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`

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Course Title	SYSTEM VERILOG AND VERIFICATION				
Course Code	23EC6PE2SV	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 of System Verilog, Layered test bench architecture and its components.	–	–
CO2	Apply the knowledge of System Verilog to build a basic verification environment.	1	3
CO3	Analyze a given design and come up with suitable test cases to achieve 100% coverage.	2	3
CO4	Develop a full System Verilog layered test bench for a given design with a suitable verification plan.	3, 5	3

UNIT – I

Verification Concepts: Concepts of verification, Importance of verification, Stimulus v/s 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

System Verilog – 1: System Verilog constructs – Data types: two-state data, strings, arrays: queues, dynamic and associative arrays, enumerated types.

Program blocks, module, interfaces, clocking blocks, modports.

UNIT – III

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, Constraint Driven Randomization, Virtual Interface.

UNIT – IV

System Verilog – 3: Assertions: Introduction to Assertion-based verification, Immediate and concurrent assertions. Understanding properties and sequences, System Verilog Assertions in design process.

UNIT – V

Coverage Driven Verification: Types of coverage, Cover Group, Cover Point, Cross Coverage, Concepts of Binning and event sampling. Layered test bench Architecture. Bug- rate, Simple functional coverage examples, Analyzing Coverage Data, Measuring Coverage Statistics During Simulation.

Text Books:

1. "Writing Testbenches Using SystemVerilog" by Janick Bergeron
2. "SystemVerilog for Verification" by Chris Spear
3. "Verification Methodology Manual for SystemVerilog" by Janick Bergeron, Eduard Cerny, Alan Hunter, and Andy Nightingale

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:

1. Seer Academy recordings

E-Books:

1. "System Verilog for Verification: A guide to learning the test bench language Features" by Chris Spear

MOOCs:

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

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Course Title	DATA ENCRYPTION AND COMPRESSION				
Course Code	23EC6PE2DE	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

OBJECTIVES:

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the various Data Encryption Techniques and Compression Techniques	–	–
CO2	Apply the various Data Encryption Techniques and Compression Techniques	1	1
CO3	Analyze the Data Encryption Techniques and Compression Techniques	2	1
CO4	Involve in independent learning on contemporary issues on various Data Encryption Techniques and Compression Techniques, Communicate effectively and prepare a report.	9, 10, 12	1, 2

UNIT – I

Introduction to Security: Need for security, Security approaches, Principles of security, Types of attacks. Encryption Techniques: Plaintext, Cipher text, Substitution and Transposition techniques, Encryption and Decryption, Types of attacks, Key range and Size.

UNIT – II

Symmetric and Asymmetric Key Cryptography: Algorithm types and Modes, DES, IDEA, Differential and Linear Cryptanalysis, RSA, Diffie Hellmann Key Exchange, Digital signature Authentication basics, Passwords, Authentication tokens, Certificate-based and Biometric authentication, Firewall

UNIT – III

Confidentiality using conventional encryption: Traffic confidentiality, key distribution, random number generation, Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete algorithms.

UNIT – IV

Need for data compression, Fundamental concept of data compression and coding, Communication model, Compression ratio, Requirements of data compression, Classification. Methods of Data Compression: Data compression - Lossless and Lossy

UNIT – V

Entropy encoding: Repetitive character encoding, Run length encoding, Zero/Blank encoding; Statistical encoding - Huffman, Arithmetic and Lempel-Ziv coding; Source encoding - Vector quantization (Simple vector quantization and with error term); Differential encoding - Predictive coding, Differential pulse code modulation, Delta modulation, Adaptive differential pulse code modulation; Transform-based coding: Discrete cosine transform and JPEG standards; Fractal compression

Text Books:

1. "Cryptography and Network Security", B. Forouzan, McGraw-Hill.
2. "The Data Compression Book", Nelson, BPB.
3. "Cryptography and Network Security", Atul Kahate, TMH.
4. "Introduction to Cryptography with coding theory", Wade Trappe and Lawrence C. Washington, Pearson.

Reference Books:

1. W. Mao, "Modern Cryptography – Theory and Practice," Pearson Education.
2. Charles P. Pfleeger and Shari Lawrence Pfleeger, "Security in computing", Prentice Hall of India.

E-Books:

1. http://pustaka.unp.ac.id/file/abstrak_kki/EBOOKS/Keamanan%20Informasi%20dan%20Jaringan%20-%20F.pdf

MOOCs:

1. https://www.coursera.org/in/articles/data-encryption-standard
2. https://nptel.ac.in/courses/106105162

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Course Title	DATA STRUCTURES USING C++				
Course Code	23EC6PE2DS	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic logical thinking, C/C++ Programming.

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply appropriate programming concepts to realize various data structures based on the understanding of various methods of realizing them.	1	1, 2
CO2	Analyze the suitability of a given data structure for a given application and realize solutions.	2	1, 2
CO3	Develop and demonstrate time and memory efficient data structure/s for given application/s.	1, 2, 5, 9, 10	1, 2

UNIT – I

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

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

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, postfix expressions).

UNIT – IV

BINARY TREES: Representation methods, Properties, Tree operations, Binary tree traversal methods and algorithms, Expression trees.
Binary search trees: Concept of dictionary, BST: representation, insertion and deletion (pseudo codes).

UNIT – V

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).

Text Books:

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

Reference Book:

1. "Data Structures Using C And C++" by Y. Langsam, M. Augenstein And A. M. Tenenbaum, Prentice-Hall Of India Pvt. Ltd., Edition 2, 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 the course. Also, applications will be developed as services using a modular approach to enrich the learning.

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Course Title	MULTI-CORE COMPUTING				
Course Code	23EC6PE2MC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Knowledge of Processor Architecture, Operating System and Basic Programming.

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the knowledge of computer architecture to understand the concepts of multicore architecture.	1	1, 2
CO2	Analyze multithreading, virtualization techniques and heterogeneous multi-core processors to evaluate the performance of multicore architecture.	2	1, 2
CO3	Present a case study highlighting the state-of-the-art advancements in Multicore Architecture	9, 10, 12	1, 2

UNIT – I

Introduction to Multi-Core Architecture, Motivation for Concurrency in Software, Parallel Computing Platforms, Parallel Computing in Microprocessors, Differentiating Multi-Core Architectures from Hyper-Threading Technology, Multi-threading on Single-Core versus Multi-Core Platforms, Understanding Performance.

UNIT – II

System Overview of Threading: Defining Threads, System View of Threads, Threading above the Operating System, Threads inside the OS, Threads inside the Hardware, Application Programming Models and Threading, Virtual Environment: VMs and Platforms, Runtime Virtualization, System Virtualization, memory hierarchy for multicore.

UNIT – III

Software Multi-threading: Threading APIs, Creating Threads, Managing Threads, Thread Pools, Thread Synchronization, POSIX Threads, Creating Threads, Managing Threads, Thread Synchronization, Signaling.

UNIT – IV

Threading on Intel Multi-Core Processors Hardware-based Threading, Hyper-Threading Technology, Difference between Multiprocessor and Hyper-Threading Technology, Hyper-Threading Technology Architecture, Multi-Core Processors, Architectural Details, Comparison between Multiprocessors and Multi-Core Processors.

UNIT – V

Introduction to Heterogeneous Multi-Core Processors Introduction to Many cores Programming, GPU Hardware, Alternatives to CUDA, OpenCL, Direct Compute CPU alternatives, Directives and libraries, Understanding Parallelism with GPUs.

Text Books:

1. "Multicore Programming" by Shameem A and Jason, Intel Press, 2006.
2. "Programming Massively Parallel Processors: A Hands-on Approach" by David B. Kirk and Wenmei W. Hwu, Morgan Kaufmann, 2010.

Reference Books:

1. "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs" by Shane Cook, Morgan Kaufmann.
2. "Multicore Computing: Algorithms, Architectures, and Applications" by Sanguthevar Rajasekaran et al., 2013.

E Books:

1. "Multicore Computing" - `https://link.springer.com/book/10.1007/978-1-4419-0263-4`

MOOCs:

1. Multicore computer architecture course - `https://onlinecourses.nptel.ac.in/noc23_cs113/preview`

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Course Title	WIRELESS SENSOR NETWORKS				
Course Code	23EC6PE2WN	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic understanding of Wireless Communication Technology, Electromagnetic spectrum, and Fundamental Networking Concepts.

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply knowledge and explain common wireless sensor node architectures and planning.	1	1
CO2	Analyze protocols developed for ad hoc and sensor networks.	2	1
CO3	Design and operate sensor networks under various environmental conditions.	3	1
CO4	Demonstrate the knowledge of routing protocols developed for WSN.	4, 5	1
CO5	Involve in independent learning on contemporary issues in sensor networks, communicate effectively, and prepare a report.	7, 9, 10, 12	1

UNIT – I

Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum, radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

UNIT – II

Introduction to ad hoc/sensor networks: Key definitions of ad hoc/sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in ad hoc wireless networks, issues in the design of sensor networks, sensor network architecture, data dissemination and gathering.

UNIT – III

MAC Protocols: Issues in designing MAC protocols for ad hoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

UNIT – IV

Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power-aware routing protocols.

UNIT – V

QoS and Energy Management: Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.

Text Books:

1. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks", Pearson Education, 2008.
2. Holger Karl and Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.
3. Feng Zhao and Leonidas J. Guibas, "Wireless Sensor Networks - An Information Processing Approach", Elsevier, 2007.

Reference Books:

1. Feng Zhao and Leonides Guibas, "Wireless Sensor Networks", Elsevier publication - 2004.
2. Jochen Schiller, "Mobile Communications", Pearson Education, 2nd Edition, 2003.
3. William Stallings, "Wireless Communications and Networks", Pearson Education – 2004.
4. Kazem Sohraby, Daniel Minoli & Taieb Znati, "Wireless Sensor Networks - Technology, Protocols, And Applications", John Wiley, 2007.
5. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.

E-Books:

1. https://mrajacse.wordpress.com/wp-content/uploads/2014/09/wireless-sensor-networks.pdf

MOOCs:

1. https://archive.nptel.ac.in/courses/106/105/106105160/

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Course Title	DESIGN OF VIRTUAL REALITY				
Course Code	23EC6PE2VR	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, the students will be able to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply the concepts of VR to Explore the research venues in Augmented Reality and Virtual Reality (AR & VR).	1	1
CO2	Analyze the basic concepts in visual computation, interactive techniques of virtual reality, and applications of VR in the digital environment.	2	1
CO3	Design the frameworks for computer-human interaction for VR applications.	3	1
CO4	Present and Explore Frameworks of Software Development Tools in VR.	4, 5, 9, 10	1

UNIT – I

Concepts and Components of Virtual Reality – Primary Features and Present Development on Virtual Reality - Multiple Models of Input and Output Interface in Virtual Reality: Input - Tracker - Sensor - Digital Glove - Movement Capture - Video-based Input - 3D Menus & 3D Scanner – Output - Visual / Auditory / Haptic Devices.

UNIT – II

Visual Computation in Virtual Reality: Fundamentals of Computer Graphics - Software and Hardware Technology on Stereoscopic Display - Advanced Techniques in CG: Management of Large Scale Environments & Real-Time Rendering.

UNIT – III

Interactive Techniques in Virtual Reality: Body Track - Hand Gesture - 3D Manus - Object Grasp, Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega - MultiGen - Virtools.

UNIT – IV

Human-Centered Interaction- Intuitiveness, Norman's Principles of Interaction Design, Direct vs. Indirect Interaction, The Cycle of Interaction, The Human Hands VR Interaction Concepts- Interaction Fidelity, Proprioceptive and Egocentric Interaction, Reference Frames, Speech and Gestures, Modes and Flow, Multimodal Interaction (Ch-25/26-TB-3).

UNIT – V

Application of VR in Digital Entertainment: VR Technology in Film & TV Production - VR Technology in Physical Exercises and Games - Demonstration of Digital Entertainment by VR.

Text Books:

1. Burdea, G. C. and P. Coffet., "Virtual Reality Technology", Second Edition, Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann, 2013.
3. Jason Jerald, "The VR Book-Human centered Design for Virtual reality", ACM publications.

Reference Books:

1. Alan Craig, William Sherman and Jeffrey Will, "Developing Virtual Reality Applications, Foundations of Effective Design", Morgan Kaufmann, 2009.

E-Books:

1. Alan Craig, William Sherman and Jeffrey Will, "Developing Virtual Reality Applications, Foundations of Effective Design", Morgan Kaufmann, 2009.

MOOCs:

1. `https://www.coursera.org/learn/3d-interaction-design-virtual-reality`

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Course Title	APPLIED ELECTRONICS				
Course Code	23EC6OE1AE	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, the students will be able to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand the basic concepts of electronic eevices and components	–	–
CO2	Apply basic electronic device knowledge for different applications	1	1
CO3	Analyze fundamental electronic devices and their characteristics	2	1

UNIT – I

Devices and basic circuits: Diodes, Clipping and Clamping, Rectification, Power-supply filtering, Zener diode regulator, BJT, JFET Structure and operation, biasing, basic logic design with transistors and diodes (TTL and CMOS).

UNIT – II

Basics of MOSFET, structures, characteristics, scaling, VLSI device structures, Complemen- tary MOSFET operation, nanoscale CMOS, finFET.

UNIT – III

Analog to Digital Conversion: Basic principles, Methods, specifications and Digital Conver- sion to Analog conversion Methods, specifications.

Data Acquisition systems: Introduction, principles of multiplexing, Sample and Hold circuit, multichannel data logging system.

UNIT – IV

Microcomputers and microprocessors: Architecture, Peripherals and Interfacing, Microcon- trollers, Applications.

Memory systems: Parameters, Classification and basic function of memory devices, Addressing and data buses, ROMs, RAM.

UNIT – V

Integrated Devices and circuits: Advantages and Limitations of ICs, scale of integration, classification, comparisons of different ICs, Digital integrated circuits, semiconductors used in fabrication of ICs, IC design and manufacturing, material preparation, crystal growing, wafer fabrication, oxidation, etching, diffusion, ion implantation, photo mask generation, photolithogra- phy, epitaxy, metallization and interconnect.

Text Books:

1. Santiram Kal, "Basic Electronics: Devices, Circuits and IT fundamentals", PHI, 2012.
2. R. S. Sedha, "Applied Electronics", S Chand Publishers, 2022.
3. N. Arora, "MOSFET models for VLSI circuit simulation", Springer, 2012.

Reference Books:

1. Millman's "Electronic Devices and Circuits", Special Indian Edition, 4/e, McGraw Hill, 2015.

MOOCs:

1. `https://www.coursera.org/learn/electronics`

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

(Autonomous College under VTU)

Course Title	INTRODUCTION TO ROBOTICS				
Course Code	23EC6OE1IR	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++ or Python.
- Linear Algebra.

Course Outcomes:

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Apply fundamental concepts of Robotics, sensors, actuators and components for developing Robotic Systems and Applications.	1	2
CO2	Analyze Robotic Systems using mathematics and engineering science for implementing systems.	2	2
CO3	Design solutions (subsystems or systems) for building Robotic System meeting the specifications for applications.	3	2
CO4	Investigate methods and approaches for building controlled, semi-autonomous, and autonomous robotic systems.	4, 5, 6, 9, 10	2

UNIT – I

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.

UNIT – II

Elements of Robotics – Sensors: Sensors, Vision and Signal Conditioning: Sensor Classification, Internal Sensors, External Sensors, Vision, Signal Conditioning, Sensor Selection.

UNIT – III

Transformations & Position Analysis: 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.

UNIT – IV

Aerial Robots: Types of UAV, Airplane, Control Surfaces, Rotary Wings, Motors and Propellers, Battery, Additional Equipment, Flight Control: Introduction, Architecture, Autopilot, Sensors Dedicated to the Flight controller, Sense And Avoid Technologies, Camera And Video, Radio Communications, Ground Control System, First Person View (FPV), Data Fusion.

UNIT – V

Robotic Operating System (ROS): ROS Architecture, Environment, Nodes, ROS Topics, Messages, Publisher, Subscriber, ROS Services and Actions, Simulation and Debugging Tools, Plotting and Data Visualization, Unified Robotic Description Format (URDF).

Text Books:

1. "Introduction to Robotics", S K Saha, McGraw Hill Education (India) Private Limited, 2nd Edition, 2014.
2. "Introduction to Robotics: Mechanics and Control", John J. Craig, Third Edition, Pearson Education Inc., 2009.
3. "Robot Operating System for Absolute Beginners", Lentin Joseph, Apress, 2018.
4. "Effective Robotics Programming with ROS", Anil Mahtani, Luis Sánchez, Enrique Fernández and Aaron Martinez, 3rd edition, Packt Publishing Ltd.
5. "A First Course in Aerial Robots and Drones", Yasmina Bestaoui Sebbane, CRC Press, 2022.

Reference Books:

1. "Introduction to Robotics: Analysis Systems and Applications", Saeed B Nikku, PHI Learning Private Limited, New Delhi, 2001.
2. "Learning Robotics using Python", Lentin Joseph, 2nd Edition, PACKT Publishing, 2015.

E-Books:

1. `https://new.abb.com/products/`
2. `https://link.springer.com/`

MOOCs:

1. `https://nptel.ac.in/courses/112105053`
2. `https://nptel.ac.in/courses/113102080`

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Course Title	RESEARCH METHODOLOGY AND IPR				
Course Code	23ES6AERMI	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 be able to:

Sl. No.	Course Outcomes	PO	PSO
CO1	Understand and commit to professional ethics and responsibilities to obtain Intellectual Property Rights like Patents, Copyright & Trademarks	8	–
CO2	Understand the impact of Patents, Copyright & Trademarks and demonstrate the knowledge for the societal and environmental context	7	–
CO3	Demonstrate the ability to choose methods appropriate to research objectives	12	–
CO4	Use IPRs to access societal, health, safety & cultural issues	6	–
CO5	Work in multiple teams to effectively communicate IP	9, 10	–

UNIT – I

Meaning and sources of research problem, Objectives and Characteristics of research – Errors in selecting research problem, Research methods v/s Methodology - Types of research-Criteria of good research – Developing a research plan.

UNIT – II

Investigations of a research problem - Selecting the problem - Necessity of defining the problem – Data collections-analysis- Importance of literature review in defining a problem -Survey of literature -Necessary instrumentations.

UNIT – III

How to write paper-conference articles-poster preparation, thesis report writing, inclusion of references, journal reviewing process, journal selection process, filling about journal template, developing effective research proposal-plagiarism-research ethics.

UNIT – IV

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.

Procedure for obtaining patent, Provisional and complete specification, Rights conferred on a patentee, Transfer of patent, Infringement of patents, Action for Infringement, Geographical indications.

UNIT – V

Copy Right: Introduction, Ownership of copy right, Rights conferred by copy right, Terms of copy right, License of copy right, Infringement of copy right, 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.

Reference Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., "An introduction to Research Methodology", RBSA Publishers, 2002
2. Kothari, C.R., "Research Methodology: Methods and Techniques", New Age International, 1990.
3. Anderson, T. W., "An Introduction to Multivariate Statistical Analysis", Wiley Eastern Pvt., Ltd., New Delhi.
4. Sinha, S.C. and Dhiman, A.K., "Research Methodology", Ess Ess Publications, 2002.
5. Subbarau N.R., "Handbook of Intellectual property law and practice", S. Viswanathan Printers and Publishing Private Limited, 1998.
6. Dr. T. Ramakrishna, "Basic Principles and Acquisition of Intellectual Property Rights", CIPRA, NSLIU, 2005.
7. Dr. B. L. Wadehhra, "Intellectual Property Law Handbook", Universal Law Publishing Co. Ltd., 2002.

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Course Title	ADVANCED SIGNAL PROCESSING LAB				
Course Code	23EC6AEASP	Credits	1	L – T – P	0:0:1
CIE	50 Marks (100% weightage)		SEE	50 Marks (100% weightage)	

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Simulate the concepts of DFT and Digital filters in spectral analysis	4, 5, 9, 10, 12	1, 3
CO2	Simulate the adaptive signal processing in various applications		
CO3	Analyse performance of different digital Filters in spectral analysis		

List of Experiments

- **Digital Filtering and Spectral Analysis**

1. Demonstration of digital filters and validate it for given signal
2. Demonstration of Frequency domain Spectral analysis of given signal using DFT
3. Demonstration of Frequency domain Spectral analysis of given signal with noise

- **Adaptive Signal Processing**

4. Demonstration of Adaptive filter for noise cancellation
5. Demonstration of Notch filter for interference cancellation
6. Demonstration of channel equalization
7. Demonstration of system identification
8. DPCM of speech signals
9. DTMF signal generation
10. Echo cancellation

- **Open-ended Experiments**

11. Study of processing of any biomedical signals (ECG, EEG)
12. Application on any signal processing to be designed as project using python with ML/DL concepts

13. Real time capture and Processing of audio signals (speech)
14. Real time capture of signals from camera and processing

Reference Books:

1. "Python for Signal Processing", José Unpingco, Springer.
2. "Think DSP: Digital Signal Processing in Python", Allen B. Downey, Franklin W. Olin College of Engineering, Green tea press.

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Course Title	**PROJECT WORK – 1**				
Course Code	**23EC6PWPJ1**	**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	Formulate the research problem by synthesizing insights from a comprehensive literature review.	1, 2, 4	1, 2, 3
CO2	Investigate contemporary tools for project implementation.	5	1, 2, 3
CO3	Produce a thorough report outlining the project and its outcomes, with the potential for publication.	3, 6, 7	1, 2, 3
CO4	Make effective communication by presentation of the work as an individual or a member of a team.	8, 9, 10, 11	1, 2, 3
CO5	Develop sustainable system with scope for enhancement and continue life-long learning.	12	1, 2, 3

VII Semester Syllabus

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Course Title	EMBEDDED SYSTEM DESIGN				
Course Code	23EC7PCESD	Credits	4	L – T – P	3:0:1
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Course Objectives:

Sl. No.	Course Outcomes	POs	PSOs
CO1	Understand the basic concepts of Embedded Systems Design	-	-
CO2	Apply the functioning and features of processors, memory, and I/O systems in developing embedded systems	1	1, 2
CO3	Analyze the embedded OS functionality and device drivers used in multitasking embedded applications	2	1, 2
CO4	Design embedded applications using given specifications and concepts of communication protocols and modules	3	1, 2
CO5	Demonstrate practical experiments on developing embedded systems	4, 5	1, 2

UNIT – I

Introduction to Embedded System: Introduction, Classification, Applications, Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other system components, PCB and Passive components, Characteristics and Quality Attributes of Embedded Systems.

UNIT – II

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

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

UNIT – IV

ARM CORTEX M3 Processor: Introduction, Architecture, LPC1768 Microcontroller: Introduction, Architectural Overview, Specifications of LPC1768, Programming in Embedded C. Examples with GPIO, UART, I2C, CAN, SPI, and various sensors.

UNIT – V

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.

Textbooks:

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 & Tony Givargis, Wiley Publication, 2006
3. ARM CORTEX M3 Data Sheet

Reference Books:

1. Embedded Systems – A contemporary Design Tool, James K Peckol, John Weily, 2008
2. Computer Organization & Embedded System, Carl Hamacher, 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 Experiments
1.	Conduction using Hardware: Interfacing an I/P device to LPC1768 and displaying the character/number entered through an O/P device
2.	Interfacing DTH Sensor to LPC1768 & reading the temp, humidity on a suitable O/P device (monitor)
3.	Interfacing an ultrasonic distance measurement device to LPC 1768 & display the distance when it is triggered
4.	Interfacing a LDR sensor to LPC 1768 to measure the LIGHT intensity
5.	Interfacing a Gas sensor to LPC 1768 to measure the Gas level and to display the value
6.	Interfacing CAN to LPC 1768 to Communicate
7.	Implement a cloud database to monitor the temp of a room (using WiFi/Ethernet)

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Course Title	**ELECTRONICS AND COMMUNICATION FOR SUSTAINABLE DEVELOPMENT**				
Course Code	**23EC7PCECS**	**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** the impact of Electronics and communication Engineering for the sustainable development	7	1, 2, 3
CO2	**Apply** the concepts of Electronics and Communication Engineering to solve societal issues	1	1, 2, 3
CO3	**Identify and analyze** the performance of the Electronic system for specific societal issues	2	1, 2, 3
CO4	**Develop** a process that meets specified needs with appropriate considerations for the environment	3	1, 2, 3

UNIT – I

Agriculture: A Review of Applications for Sensor Networks in Smart Agriculture, Wireless sensor networks with dynamic nodes for water and crop health management.

UNIT – II

Environment: Scaling Smart Environments, Localization of a wireless sensor network for environment monitoring using likelihood Estimation with negative Constraints, Reconfigurable Intelligent Space, and the mobile module for Flexible Smart Space.

UNIT – III

Energy: Sensor Networks for Energy Sustainability in Buildings, Wireless Sensor and Actor Networks for monitoring and Controlling Energy use in Smart grid, Mobile monitoring application to support sustainable behavior change toward healthy lifestyle.

UNIT – IV

Healthcare: Sensor networks in healthcare, Use of Body Sensor networks in Clinical settings and Medical Research.

UNIT – V

Transportation: Social sensor networks for Transportation Management in smart cities, Applying RFID Techniques for the Next generation automotive services.

Reference Book:

1. "Sensor Networks for Sustainable Development", Mohammad Ilyas, Sami S. Alwakeel, Mohammed M. Alwakeel, el-Hadi M. Aggoune, June 25, 2014 by CRC Press, Reference - 568 Pages - 239 B/W Illustrations, ISBN 9781466582064 - CAT# K18915.

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Course Title	SPEECH PROCESSING				
Course Code	23EC7PE3SP	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	POs	PSOs
CO1	Model speech production system and discuss the fundamentals of speech.	-	-
CO2	Apply time domain and frequency domain algorithms on speech to find, enhance, and modify speech parameters.	1	2
CO3	Analyze an appropriate processing technique for speech recognition, synthesis, and speaker identification systems.	2	2

UNIT – I

Fundamentals of Human Speech Production: The Process of Speech Production, Short-Time Fourier representation of Speech, The Acoustic Theory of Speech production, Digital Models for Sampled Speech Signals.

UNIT – II

Time-Domain Methods for Speech Processing: Introduction to Short-Time Analysis of Speech, Short-Time Energy and Short-Time Magnitude, Short-Time Zero-Crossing Rate, The Short-Time Autocorrelation Function.

UNIT – III

Frequency Domain Representations: Discrete-Time Fourier Analysis, Short-Time Fourier Analysis, Overlap Addition (OLA) and Filter Bank Summation (FBS) Method of Synthesis, Time-Decimated Filter Banks.

UNIT – IV

Linear Predictive Analysis of Speech Signals: Basic Principles of Linear Predictive Analysis, Computation of the Gain for the Model, Frequency Domain Interpretations of Linear Predictive Analysis, Solution of the LPC Equations, The Prediction Error Signal.

UNIT – V

Recent Advancements in Speech Processing with Deep Learning: Basics of deep learning, data-driven approaches to modeling speech, transformation of representations for linear discrimination, deep learning approaches for Text-To-Speech (TTS) synthesis, Speech-To-Text (STT) or automatic speech recognition (ASR) systems.

Text Books:

1. "Digital Processing of Speech Signals", L R Rabiner and R W Schafer, Pearson Education Asia, 2004.
2. "Theory and Applications of Digital Speech Processing", Rabiner and Schafer, Pearson Education 2011.

Reference Books:

1. "Fundamentals of Speech Recognition", Lawrence Rabiner and Biing-Hwang Juang, Pearson Education, 2003.
2. "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Daniel Jurafsky and James H Martin, Pearson Prentice Hall, 2009.

Online Material:

1. https://speech.zone/courses/speech-processing/
2. https://www.ee.iitb.ac.in/~pcpandey/notes/pcp/pcp_notes_speech_processing_jan08.doc
3. https://old.amu.ac.in/emp/studym/99992324.pdf
4. https://sites.google.com/site/samahghanem/lecture-notes-in-speech-signal-processing
5. https://www.studocu.com/en-gb/document/university-of-sheffield/speech-processing/speech-processing-notes-l1-10/6881951

E-Books:

1. https://www.gale.com/ebooks/9781599041346
2. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118142882

MOOCs:

1. https://www.my-mooc.com/en/mooc/speech-recognition-systems/

Note: The Course will be supplemented by hands-on lab sessions using MATLAB

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Course Title	OPTICAL COMMUNICATION				
Course Code	23EC7PE3OC	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Basic understanding of communication systems

Course Outcomes:

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

Sl. No.	Course Outcomes	POs	PSOs
CO1	Understand the concept of devices and circuits in optical communication systems.	–	–
CO2	Apply the principle of various theorems to obtain the parameters of optical communication system.	1	2
CO3	Analyze the performance parameters of optical communication systems for the given specifications.	2	2

UNIT – I

Introduction to Optical Fibers: Overview of Optical Fiber Communication, Optical Fiber Waveguides, Different Modes: Single, Multi-mode, Skew Rays, Cut-off Wavelength, Mode Field Diameter, Optical Fiber Manufacturing.

UNIT – II

Transmission Characteristics of Optical Fiber: Transmission Characteristics of Optical Fibers, Attenuation, Absorption, Scattering Losses, Bending Loss, Dispersion, Intra-modal Dispersion, Inter-modal Dispersion.

UNIT – III

Optical Sources and Detectors: Introduction to Optical Sources and Detectors, LEDs, Laser Diodes, Photodetectors, Photo Detector Noise, Response Time, Double Hetero-junction Structure, Comparison of Photodetectors.

UNIT – IV

Optical Receivers: Introduction, Amplifiers, Noise Sources, Noise, State of the Art Optical Receivers.

Semiconductor Optical Amplifiers: Performance Characteristics, Gain Clamping, Quantum Dots, Link Budget Analysis.

UNIT – V

Optical Amplifiers and Networks: Basic Applications, Amplification Mechanisms, Semiconductor Optical Amplifiers, WDM Networks, Introduction: WDM Network Applications– DWDM and CWDM Networks.

Text Books:

1. P. Chakrabarti, "Optical Fiber Communication", McGraw Hill Education (India) Private Limited, 2016 (Units I, II, III)
2. Gred Keiser, "Optical Fiber Communication", McGraw Hill Education (India) Private Limited, Fifth Edition, Reprint 2013 (Units I, IV, V)

Reference Books:

1. John M. Senior, "Optical Fiber Communication", Pearson Education, Second Edition, 2007
2. Rajiv Ramaswami, "Optical Networks", Second Edition, Elsevier, 2004
3. J. Gower, "Optical Communication Systems", Prentice Hall of India, 2001
4. Govind P. Agrawal, "Fiber-optic Communication Systems", Third Edition, John Wiley & Sons, 2004

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Course Title	PHYSICAL DESIGN				
Course Code	23EC7PE3PD	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.	–	–
CO2	**Apply** the knowledge of physical design flow for partitioning, floor-planning, placement problems and timing constraints	1	3
CO3	**Analyze** the given scenario to obtain the desired optimal solution for partitioning, floor planning, placement and timing closure	2	3

UNIT – I

Electronic Design Automation (EDA): VLSI Design Flow, VLSI Design Styles, Physical Design Optimizations, EDA Terminology. Libraries: Standard Cells, Transistor Sizing, I/O Pads, Input File formats for Physical Design, Delay models for library characterization.

UNIT – II

System Partitioning: Terminology, Optimization Goals, Partitioning Algorithms: Kernighan-Lin, Extensions of Kernighan-Lin, Fiduccia-Mattheyses, Multilevel Partitioning, System Partitioning onto Multiple FPGAs.

UNIT – III

Floorplanning: Optimization Goals, Terminology, Simulated Annealing Algorithm, Macro Placement, Pin Assignment, Power and Ground Routing.

Placement: Optimization Objectives, Algorithms: Force-directed Placement, Simulated Annealing (Timberwolf), Legalized and Detailed Placement.

UNIT – IV

Clock Tree Synthesis: Basic Concepts in Clock Networks, Modern Clock Tree Synthesis: H-tree, Method of Means and Medians, Clock Tree Buffering.

Timing Closure: Introduction, Static Timing Analysis.

UNIT – V

Routing: Goals of Routing, Routing Prerequisites, Routing Constraints, Global Routing, Track Assignment, Detail Routing, Design Rule Check (DRC), Layout versus Schematic (LVS), Commonly faced LVS issues, Static and Dynamic IR drop analyses, Methods to reduce IR drop, Electro-migration (EM), Methods to fix EM.

Text Books:

1. "Physical Design Essentials: An ASIC Design Implementation Perspective", Khosrow Golshan, Springer Science+Business Media, 2007.
2. "VLSI Physical Design: From Graph Partitioning to Timing Closure", Andrew B. Kahng, Jens Lienig, Igor L. Markov and Jin Hu, Springer Science+Business Media, 2011.

Reference Books:

1. "Algorithms for VLSI Physical Design Automation", Naveed A. Sherwani, Springer.
2. "An Introduction to VLSI Physical Design", Majid Sarrafzadeh and C. K. Wong, McGraw Hill International Edition 1995.
3. "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/Synopsys EDA tools.

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Course Title	3D MODELLING FOR VIRTUAL RELAITY				
Course Code	23EC7PE3VR	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	POs	PSOs
CO1	Apply the concepts of geometric modeling and virtual environments.	1	1
CO2	Analyse the virtual hardware and software by using appropriate tools	2	1
CO3	Develop virtual reality applications for different domains.	3	1

UNIT – I

Virtual Reality Environment: Overview of Optical Fiber Communication, Optical Fiber Waveguides, Different Modes: Single, Multi-mode, Skew Rays, Cut-off Wavelength, Mode Field Diameter, Optical Fiber Manufacturing.

UNIT – II

Geometric Modelling: Geometric Modelling: Introduction, From 2D to 3D, 3D Space Curves, 3D Boundary Representation, Geometrical Transformations, VR Systems.

UNIT – III

Virtual Environment: Animating the Virtual Environment, Challenges & Opportunities, Creating Interactive Elements, Optimizing Graphics & High-performance Devices, Creation of 3D art, Simulation Environment.

UNIT – IV

VR Hardware and Software: Human Factors considerations in VR, VR Hardware requirements, Choosing a Headset, Headsets, VR Software- Supported 3D Modeling File Types for VR, Software requirements specification for VR Construction Training System.

UNIT – V

Strategies for Designing and Developing 3D User Interfaces: Designing for Humans, Inventing 3D User Interfaces, Feedback in 3D User Interfaces, Constraints, Two-Handed Control, Designing for Different User Groups.

Text Books:

1. John Vince, “Virtual Reality Systems”, Pearson Education Asia, 2007
2. Anand R., “Augmented and Virtual Reality”, Khanna Publishing House, Delhi
3. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000
4. Joseph LaViola Jr., “3D User Interfaces: Theory and Practice”, Second Edition, Addison-Wesley Professional, 2017

Reference Books:

1. www.vresources.org
2. www.vrac.iastate.edu
3. www.w3.org/MarkUp/VRM
4. https://www.e-education.psu.edu/geogvr/node/80016

E-resource:

1. https://archive.nptel.ac.in/courses/121/106/121106013/

MOOCs:

1. https://www.coursera.org/learn/3d-models-virtual-reality

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Course Title	STEGANOGRAPHY AND DIGITAL WATERMARKING				
Course Code	23EC7PE3SW	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	POs	PSOs
CO1	Understand the principles and concepts of steganography and digital watermarking.	-	-
CO2	Apply perceptual models and robust watermarking approaches.	1	1
CO3	Analyze different watermarking models and message coding techniques.	2	1

UNIT – I

Introduction: Information Hiding, Steganography and Watermarking, History of Watermarking, Importance of Digital Watermarking, Applications, Properties, Evaluating Watermarking Systems, Watermarking Models & Message Coding.

UNIT – II

Watermarking with Side Information: Informed Embedding as an optimization Problem, Optimizing with respect to a detection statistic and an estimate of robustness, Dirty paper codes, Informed Coding, Structured Dirty-Paper Codes, Analyzing Errors.

UNIT – III

Perceptual Models: Evaluating Perceptual Impact, General Form of a Perceptual Model, Two examples of Perpetual Models, perpetually adaptive watermarking, Robust Watermarking Approaches, Robustness to volumetric distortions.

UNIT – IV

Watermark Security & Authentication: Security Requirements: restricting water mark operations, public and private watermarking, Categories of attack, Watermark Security and Cryptography: analogy between watermarking and cryptography, preventing unauthorized detection, embedding and removal, Attacks, Authentication Techniques.

UNIT – V

Steganography: Steganography Communication, channel, Building blocks, Information Theoretic Foundations, Practical Methods, Minimizing the embedding impact, Steganalysis: steganalysis scenarios, significant algorithms.

Text Books:

1. Ingemar J. Cox et al., "Digital Watermarking and Steganography", Morgan Kaufmann Publishers, New York, 2008
2. Ingemar J. Cox et al., "Digital Watermarking", Morgan Kaufmann Publishers, New York, 2003

Reference Books:

1. Michael Arnold et al., "Techniques and Applications of Digital Watermarking and Content Protection", Artech House, London, 2003
2. Juergen Seits, "Digital Watermarking for Digital Media", IDEA Group Publisher, New York, 2005
3. Peter Wayner, "Disappearing Cryptography – Information Hiding: Steganography & Watermarking", Morgan Kaufmann Publishers, New York, 2002

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(Autonomous College under VTU)

Course Title	DATA ANALYTICS AND SECURITY IN IOT				
Course Code	23EC7PE3DA	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	POs	PSOs
CO1	Understand the fundamentals of Database Analytics and Security	–	–
CO2	Apply database analytics and Security for IoT applications	1	1
CO3	Analyze IoT system using database analytics and Security for given specifications	2	1

UNIT – I

Introduction to Technological Developments: Defining IoT Analytics and Challenges- Defining IoT analytics, IoT analytics challenges, Business value concerns, IoT Devices and Networking Protocols – IoT devices, Networking basics, IoT networking connectivity protocols, analyzing data, IoT Analytics for the Cloud Building elastic analytics, Designing for scale, Cloud security and analytics, The AWS, Microsoft Azure, The Thing Worx overview.

UNIT – II

Introduction to Big Data: Introduction to Bigdata Platform, Traits of Big data, Challenges of Conventional Systems, Web Data, Evolution of Analytic Scalability, Analysis vs Reporting, Statistical Concepts: Sampling Distributions, Re-Sampling, Statistical Inference, Prediction Error.

UNIT – III

Cloud Analytics Environment: The AWS Cloud Formation, The AWS Virtual Private Cloud (VPC), terminate and clean up the Environment, data processing for analytics, big data technology to storage, Apache Spark for data processing, handling change, Exploring, and visualizing data, Techniques to understand data quality, R and R Studio.

UNIT – IV

Societal Impact of Multimedia Big Data: Multimedia Social Big Data Mining, Process Model, SWOT Analysis, Techniques for Social Big Data Analytics, Advertisement Prediction, MMBD Sharing on Data Analytics Plat form, Legal/Regulatory Issues.

UNIT – V

Application Environments: Big Data Computing for IoT Applications-Precision Agriculture, Machine Learning in Improving Learning Environment, Network-Based Applications of Multimedia Big Data Computing, Recent Trends in IoT-Based Analytics and Big Data, Future Directions and Challenges of Internet of Things.

Text Books:

1. Andrew Minteer, "Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices", Packt Publishing, first edition, July 2017.
2. Sudeep Tanwar, Sudhanshu Tyagi, Neeraj Kumar, "Multimedia Big Data Computing for IoT Applications: Concepts, Paradigms and Solutions", Springer, 2020.

Reference Books:

1. John Soldatos, "Building Blocks for IoT Analytics", River Publishers Series In Signal, Image and Speech Processing, 2017.
2. Nilanjan Dey, Aboul Ella Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Chandra Satapathy, "Internet of Things and Big Data Analytics Toward Next-Generation Intelligence", Springer International Publishing, 2018.
3. Stackowiak, R., Licht, A., Mantha, V., Nagode, L., "Big Data and The Internet of Things Enterprise Information Architecture for A New Age", A press, 2015.
4. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley publications, 2014.

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Course Title	FIRMWARE DESIGN				
Course Code	23EC7PE3FD	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	POs	PSOs
CO1	Apply the knowledge of basic hardware and microcontroller programming to develop embedded firmware.	1	3
CO2	Analyze firmware design patterns and develop firmware for interrupts, timers, and communication protocols.	2	3
CO3	Present a case study analyzing literature on advanced topics in embedded firmware design.	9, 10	3

UNIT – I

Introduction to Embedded Firmware Design: Definition and Scope of Embedded Firmware, Firmware Development Process Overview, Challenges in Embedded Systems, Reading Datasheets and Technical Documents, Embedded Software Development Tools and Debugging Techniques, Microcontroller Programming using C.

UNIT – II

Interrupts and Communication Protocols: Importance of Interrupts, Timer Modules and Applications, Implementing Interrupt-Driven Systems, Serial Communication Overview (UART, SPI, I2C), Implementing Communication Protocols in Firmware, Interfacing with Sensors and Actuators.

UNIT – III

Wireless Communication in Embedded Systems: Wireless Communication Protocols (e.g., Bluetooth, Wi-Fi), Implementing Wireless Communication in Firmware, IoT Concepts and Applications.

UNIT – IV

Firmware Design Patterns: Code Organization and Modularization, Memory Management and Optimization Techniques, Power Management in Embedded Systems, Security Considerations, Firmware Updates and Version Control.

UNIT – V

Emerging Trends in Embedded Firmware Design: Edge Computing Impact on Firmware Design, Machine Learning at the Edge, Future Directions in Embedded Systems and Firmware Design.

Text Books:

1. Arnold S. Berger, "Embedded Systems Design: An Introduction to Processes, Tools, and Techniques", CMP Books, 2002.
2. Michael Barr, "Programming Embedded Systems: With C and GNU Development Tools", O'Reilly, 2nd Edition.
3. "The Firmware Handbook: The Definitive Guide to Embedded Firmware Design and Applications", Elsevier, 2004.

Reference Books:

1. Vincent Himpe, "Serial Communication: UART, SPI, and I2C"
2. Elecia White, "Making Embedded Systems: Design Patterns for Great Software", O'Reilly, 2011.

E-Books:

1. https://www.oreilly.com/library/view/making-embedded-systems/9781098151539/

MOOCs:

1. https://www.udemy.com/course/firmware-engineering/

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Course Title	JAVA SCRIPTING				
Course Code	23EC7PE3JS	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	POs	PSOs
CO1	Apply HTML and JavaScript constructs for given applications.	1	2
CO2	Design static and interactive web pages for an application.	3	2
CO3	Use appropriate software and design web pages.	5	2

UNIT – I

HTML for Web Design: HTML elements, nesting of HTML elements, HTML attributes, some HTML elements: section elements, text content, forms, images, links, comments in HTML, using HTML entities, create a HTML document.

UNIT – II

Introduction to JavaScript: The World Wide Web, extending HTML, CGI, JavaScript in a browser, Client-side JavaScript, applications of Java Script.

Writing a JavaScript: Choosing a text editor, choosing a browser, JS structure, JS and HTML – page layout, command blocks.

UNIT – III

JavaScript Basics: Data Types, variables, literals, expressions, using JavaScript operators, loops, Arrays, array methods, functions.

UNIT – IV

Events in JavaScript: Events, global event attributes, window event attributes, Handlers, event handlers for forms, common form events, other form events.

UNIT – V

Creating Interactive Forms, Basic elements of webforms, form objects and properties, validating forms, form elements, dynamic form elements, using tables, using arrays.

Reference Books:

1. Yehuda Shiran & Tomar Shiran, "Learn Advanced JavaScript Programming", BPB Publications.
2. Arman Danesh, "JavaScript Interactive Course", Techmedia.

Online Resources:

1. Programming in Java - IIT Kharagpur – Lecture 25 Javascript – Part :1
2. Lecture Series on Internet Technologies by Prof. I. Sengupta, Department of Computer Science Engineering, IIT Kharagpur. Lecture 26 `http://nptel.iitm.ac.in`
3. Introduction to Web Development with HTML, CSS, JavaScript by IBM at Coursera

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Course Title	**DEEP LEARNING**				
Course Code	**23EC7PE3DL**	**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**	**POs**	**PSOs**
CO1	Apply mathematics and programming skills to structure datasets and algorithms for building deep learning models.	1	2
CO2	Analyze activation functions and optimization techniques for feed-forward and backpropagation in model training.	2	2
CO3	Design and develop application models using deep neural networks, feature engineering, and cross-validation techniques.	3, 5	2

UNIT – I

Introduction to Deep Learning: Review of Machine Learning, Introduction to Deep Learning, Mathematics Behind Machine Learning (Linear Algebra, Statistics), Machine Learning Principles (Regression, Classification, Clustering), Introduction to Python Libraries (TensorFlow, Keras).

UNIT – II

Neural Networks: 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 & Classification.

UNIT – III

Optimization and Model Training: Optimization Algorithms, Hyperparameters (Learning Rate, Regularization, Momentum, Sparsity), Fully Connected Neural Network, Model Training & Evaluation, Use Cases and Model Building.

UNIT – IV

Architectures of Deep Networks: Convolutional Neural Network (CNN) 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

Sequential Data and Recurrent Neural Networks (RNN): Recurrent Neural Network (RNN) Architecture, Training RNN with Text Data, LSTM Network, Training LSTM Network, Autoencoder, Generative Networks, Chatbots, Applications of RNN & LSTM, Use Cases & Model Building.

Text Books:

1. Josh Patterson & Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Publications, 2019.
2. Francois Chollet, "Deep Learning with Python", Manning Publications, 1st Edition, Manning Publications, 2017.

Reference Books:

1. Jake VanderPlas, "Python Data Science Handbook", O'Reilly Publications, 2016-17.
2. Aurélien Géron, "Hands-on Machine Learning with ScikitLearn & TensorFlow", O'Reilly Publications, 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

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Course Title	POWER ELECTRONICS				
Course Code	23EC7OE2PE	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	POs	PSOs
CO1	Apply basic circuit theory concepts to solve power electronics circuits	1	1
CO2	Identify and Analyze power electronic circuits for a given application and draw valid conclusions with suitable assumptions	2	1
CO3	Design solutions to meet the given specifications of a power converters and basic triggering circuits.	3	1

UNIT – I

Introduction to Power Electronics: Introduction, Applications, Advantages and disadvantages of power electronics, Classification of Power semiconductor devices (Diode, SCR, MOSFET & IGBT), Types of power electronics circuits or converters, Control Characteristics, Peripheral effects.

UNIT – II

Introduction to Thyristors: Two-transistor model, Turn-on Methods, Dynamic Turn-on and turn-off characteristics, Gate characteristics, Gate trigger circuits, di/dt and dv/dt protection. Principle of Commutation techniques, Natural commutation, Forced Commutation: Self Commutation.

UNIT – III

Controlled Rectifiers: Introduction, Principle of phase-controlled converter operation, Single-phase semi-converters, Single-phase fully controlled converters, Dual converters (No derivation for all converters with *RL* load). Design examples.

UNIT – IV

DC-DC Converters: Introduction, principle of step-down (buck) and step-up (boost) choppers (R-load only), performance parameters. Switched-mode regulators: buck regulator, boost regulator, Buck boost regulator.

UNIT – V

Inverters: Introduction, Principle of operation, Performance parameters, Single-phase bridge inverter (VSI), current source inverter (CSI), Variable DC link inverter, Introduction to multilevel inverters.

Text Books:

1. M. H. Rashid, "Power Electronics", 2nd Edition, PHI / Pearson publisher, 2004.
2. M. D. Singh and Kanchandani K.B., "Power Electronics", TMH publisher, 2nd Edition, 2007.
3. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics", 3rd Edition, Wiley Publication, 2002.
4. P. S. Bimbhra, "Power Electronics", Khanna Publications, 2012.

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Course Title	SIGNAL PROCESSING				
Course Code	23EC7OE2SP	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	POs	PSOs
CO1	Understand the concepts of signal processing and its applications in various domains.	-	-
CO2	Apply the concepts of various theorem to understand the basics of signals, systems and signal processing.	1	1
CO3	Analyse the operation of signals on various systems for the given set of specifications	2	1

UNIT – I

Signals: Definition of Signals, Classification of Signals, Basic Operations on Signals, Operations Performed on the Independent and Dependent Variable, Precedence Rule, Elementary Signals.

UNIT – II

Systems: Definition of Systems, System Viewed as Interconnection of Operations, Properties of Systems, Difference equation representation for LTI systems and solution of difference equations.

UNIT – III

Discrete Time Fourier Transform (DTFT), Properties of DTFT (No Derivations), z-Transform, Properties of z-Transform (No Derivations), Unilateral z-transform and solution of difference equations. Comparisons of different Transforms.

UNIT – IV

Introduction to multimedia, information representation, multimedia networks, multimedia applications, Application and networking terminology, network QoS and application QoS, Digitization principles, Text, images, audio and video.

UNIT – V

Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in biomedical analysis. Electrocardiography: Basic electrocardiography, ECG leads systems, ECG signal characteristics. Signal Conversion: Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuit.

Text Books:

1. "Signals and Systems", Simon Haykin and Barry Van Veen, 2nd Edition, 2008, John Wiley & Sons.
2. "Biomedical Digital Signal Processing", Willis J. Tompkins, PHI 2001.
3. "Biomedical Signal Processing Principles and Techniques", D C Reddy, McGraw-Hill publications, 2005.
4. "Multimedia Communications", Fred Halsall, Pearson education, 2001.

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Course Title	ENGINEERING MATERIALS AND SENSORS				
Course Code	23EC7OE2EM	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	POs	PSOs
CO1	Apply concepts of physics and chemistry to identify the application of materials in various engineering domains	1	1
CO2	Analyse 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	9, 10	1

UNIT – I

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

Materials: Silicon as sensing element, Plastics, thermoplastics, Metals, Glasses, Ceramics.

Material Deposition: Thermal Evaporation, e-beam evaporation, sputtering spin coating CVD techniques.

UNIT – III

Material Characterization: XRD, SEM, AFM, TEM, Van der Paul method of resistance measurement.

Sensor Applications: Strain gauge, Tactile sensor as a switch, Mercury Pressure sensor, Displacement sensor (LVDT), Temperature sensor (thermocouple).

UNIT – IV

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 – V

Electrical properties: 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, temp dependence of carrier concentration, factors that affect carrier mobility, Hall effect.

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. "Handbook of Modern Sensors: Physics, Designs, and Applications", Jacob Fraden, Springer Publications, Third Edition.

Reference Books:

1. "Material Science and Engineering", William D. Callister, 2nd edition, Wiley.
2. "Sensors Handbook", Sabrie Soloman, Mc Graw Hill publication, Second Edition.

MOOCs:

1. https://nptel.ac.in/courses/112105053
2. https://nptel.ac.in/courses/113102080

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Course Title	ROBOTIC SYSTEMS AND CONTROL				
Course Code	23EC7OE2RS	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, the student will have the ability to:

Sl. No.	Course Outcomes	POs	PSOs
CO1	Apply fundamentals of Robotics, components, and systems for applications.	1	2
CO2	Analyze mathematical and engineering concepts used in Robotics systems.	2	2
CO3	Demonstrate design skills for building industrial Robotic System meeting the specifications for a particular application.	3	2
CO4	Investigate autonomous robotic systems for specific applications.	4, 9, 10	2

UNIT – I

Introduction to Robotics & Transformations: Robot Usage, Industrial Robots and Their Applications, Robot Subsystems Robot Architecture, Pose of a Rigid Body, Degree Of Freedom, Coordinate Transformation and the associated matrix manipulations, Denavit and Hartenberg (DH) Parameters and their computations for various industrial Robot Configurations.

UNIT – II

Kinematics of Industrial Robots: Forward Position Analysis and computations, Inverse Position Analysis and considerations, Velocity Analysis and considerations, Jacobian Matrix, Link Velocities, Jacobian Computation using the Jacobian Matrix, Forward Velocity Analyses and Inverse Velocity Analyses, Acceleration Analysis for Industrial Robots and the considerations.

UNIT – III

Robot Motion, Odometry, and Control: Distance, Time, Velocity, and Acceleration, Segments to Continuous Motion, Navigation by Odometry, Linear Odometry, Errors in Odometry – a brief discussion, Wheel Encoders, Control Models (Open Loop, Closed loop, Period of CA, On-Off Control, Proportional (P) Controller, Proportional Integral (PI) Controller, Proportional-Integral-Derivative (PID) Controller).

UNIT – IV

Local Navigation and Localization: Obstacle Avoidance (Wall, wall with direction, pledge), Following a Line with a Code, Ants Searching for a Food Source, A Probabilistic Model of the Ants' Behavior, A Finite State Machine for the Path Finding Algorithm. Localization-Introduction, Landmarks, Determining Position from Objects Whose Position Is Known, Global Positioning System, Probabilistic Localization, Uncertainty in Motion.

UNIT – V

Mapping and Mapping-Based Navigation: Discrete & Continuous Maps, The Content of Cells of a Grid Map, Creating Map by Exploration: The Frontier Algorithm, Mapping Using Knowledge of Environment, Numerical Example, Formalization of SLAM. Mapping-Based Navigation-Introduction, Dijkstra's Algorithm for Grid Map & Continuous Map, Path Planning with the A* Algorithm, Path Following and Obstacle Avoidance.

Text Books:

1. S K Saha, "Introduction to Robotics", McGraw Hill Education (India) Private Limited, 2nd Edition, 2014.
2. John J. Craig, "Introduction to Robotics: Mechanics and Control", Third Edition, Pearson Education Inc, 2009.
3. Mordechai Ben-Ari and Francesco Mondada, "InterElements of Robotics", 2018.

Reference Books:

1. Saeed B Nikku, "Introduction to Robotics: Analysis Systems and Applications", 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
2. https://link.springer.com/book/10.1007/978-981-19-1983-1

MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_de11/preview
2. https://www.my-mooc.com/en/categorie/robotics

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Course Title	**PROJECT WORK – 2**				
Course Code	**23EC7PWPJ2**	**Credits**	**2**	**L – T – P**	**0:0:8**
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	Formulate the research problem by synthesizing insights from a comprehensive literature review.	1, 2, 4	1, 2, 3
CO2	Investigate contemporary tools for project implementation.	5	1, 2, 3
CO3	Produce a thorough report outlining the project and its outcomes, with the potential for publication.	3, 6, 7	1, 2, 3
CO4	Make effective communication by presentation of the work as an individual or a member of a team.	8, 9, 10, 11	1, 2, 3
CO5	Develop sustainable system with scope for enhancement and continue life-long learning.	12	1, 2, 3

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Course Title	INDIAN KNOWLEDGE SYSTEMS				
Course Code	25MA7HSIKL	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	POs	PSOs
CO1	**Provide** an overview of the concept of the Indian Knowledge System and its importance.	1	–
CO2	**Appreciate** the need and importance of protecting traditional knowledge.	1	–
CO3	**Recognize** the relevance of Traditional knowledge in different domains.	1	–

UNIT – I

Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.

UNIT – II

Traditional Knowledge in Humanities and Sciences: Linguistics, Number and measurements – Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.

UNIT – III

Traditional Knowledge in Professional domain: Town planning and architecture – Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.

Reference Books:

1. "Introduction to Indian Knowledge System – Concepts and Applications", B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0.
2. "Traditional Knowledge System in India", Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230.
3. "Knowledge Traditions and Practices of India", Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334.

E-Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/
3. https://www.iitkgp.ac.in/department/KS (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4. https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5. https://unctad.org/system/files/official-document/ditcted10_en.pdf
6. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7. https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE

VIII Semester Syllabus

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Course Title	MULTIMEDIA COMMUNICATION				
Course Code	23EC8PE4MC	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	POs	PSOs
CO1	Apply the basic communication knowledge on multimedia with applications	1	2
CO2	Analyze various data compression techniques and algorithms for audio and video systems	2	2
CO3	Explore different multimedia concepts applied to the internet	6	2

UNIT – I

Information Representation: Multimedia information representation: Introduction, Digitization Principles, Representation of Text, Images, Audio & Video; Multimedia applications: Media composition, Media communication, Media entertainment.

UNIT – II

Compression Techniques: Various Compression Principles; Text Compression: Static Huffman Coding, Dynamic Huffman Coding, Arithmetic Coding, Lempel-ziv Coding; Image Compression: Graphics Interchange Format, Tagged Image File Format, Digitized Document, Digitized Pictures, JPEG2000.

UNIT – III

Audio Compression: Adaptive differential PCM, Code excited LPC, MPEG audio coders, Dolby audio coders; Video Compression: Basic principles, Video compression standard h.263, MPEG-4. Embedded Wavelet coding: Zero tree approach, SPIHT algorithm, EBCOT algorithm.

UNIT – IV

Internetworking: QoS: Admission Control, Integrated & Differentiated Services, RSVP; Internet Applications: DNS, Name Structure and Administration, DNS Resource Records; Electronic Mail Message Structure, Content Transfer, Basic Concept of Internet Telephony, World Wide Web.

UNIT – V

Broadband Internet: Broadband ATM Networks, Entertainment Networks, High-Speed Modems; Multimedia over Wireless Channel, Digital Broadcast, Media Streaming, Content-based Media Access.

Text Books:

1. F. Halsall, "Multimedia communications: Applications, Networks, protocols and standards", Pearson Education Ltd., 2001.
2. R. Steinmetz and K. Nahrstedt, "Multimedia: Computing, Communications & Applications", Pearson Education Inc., 1995.

Reference Books:

1. K. R. Rao, Zoran S. Bojkovic and Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004.
2. John Billamil and Louis Molina, "Multimedia: An Introduction", PHI, 2002.
3. Jens-Rainer Ohm "Multimedia Communication Technology", C Springer-Verlag, Berlin Heidelberg, 2004.

MOOCs:

1. NPTEL Multimedia Communication Systems: `www.nptel.ac.in/courses/117105083`

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Course Title	NEXT GENERATION NETWORKS				
Course Code	23EC8PE4NG	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	POs	PSOs
CO1	Acquire the Knowledge of network Architecture, Energy and Power management Techniques in Next generation networks	–	–
CO2	Apply the knowledge of Traffic Engineering, Software Defined Radio and Green Communication networks to Next generation mobile networks	1	1
CO3	Analyze the Energy saving and power management scenarios in in Green Radio and next generation networks	2	1

UNIT – I

Introduction to Wireless Networks and Standards: Evolution from 2G to 5G- key technologies, challenges and performance comparison. Traffic Engineering - Network traffic load and parameters, grade of service and blocking probability, Call blocking and Traffic computation using Erlang B.

UNIT – II

Terrestrial microwave long haul, mobile radio systems: Data services in next generation communication services and non-terrestrial digital microwave communication services, Synchronous digital hierarchy.

UNIT – III

Introduction to Network Virtualization and SDN: Introduction to Virtualization, Virtual Machine, virtual networks, architecture, NFV functionality, network virtualization, modern networking approaches to virtualization, Software Defined Networks - background, application, SDN data plane, SDN control plane and SDN application plane.

UNIT – IV

Green communications and networks: Energy-saving techniques, Power Management, spectrum and load management in cellular wireless base stations, Power-management for base stations, Energy-efficient relaying for cooperative cellular wireless networks, Resource allocation for green communication in relay-based cellular networks, concept of Green Radio Test-Beds.

UNIT – V

6G Key Trends: Self-organising networks and spectrum sharing, Wireless energy harvesting, wireless powered communication networks, applications in healthcare, wireless drones in agriculture, EVs, performance measure-outage probability and throughput. Spectrum sensing and sharing, resource allocation using NOMA, mmWave and MIMO. Introduction to Intelligent reflecting surfaces.

Text Books:

1. Kao-Cheng Huang, Zhaocheng Wang, "Millimeter wave communication systems", John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
2. M. Vaezi, Z. Ding, and H. V. Poor, "Multiple Access techniques for 5G Wireless Networks and Beyond", Springer Nature, Switzerland, 2019.
3. Binod Kumar Kanaujia, Neeta Singh, Sachin Kumar, "Rectenna: Wireless Energy Harvesting System", Springer, 2021.
4. Ekram Hossain, Vijay K. Bhargava (Editor), Gerhard P. Fettweis (Editor), "Green Radio Communication Networks", Cambridge University Press, 2012.
5. F. Richard Yu, Yu, Zhang and Victor C. M. Leung "Green Communications and Networking", CRC press, 2012.

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

(Autonomous College under VTU)

Course Title	REAL-TIME SYSTEMS				
Course Code	23EC8PE4RT	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, the student will have the ability to:

Sl. No.	Course Outcomes	POs	PSOs
CO1	Apply the concepts of real time system for computer control.	1	2
CO2	Analyze hardware and software requirements and various design approaches to develop real time systems.	2	2
CO3	Present a case study analyzing literature on advanced topics on real time system design.	9, 10	2

UNIT – I

Introduction to Real Time Systems: Historical background, Elements of a Computer Control System, RTS–Definition, Classification of Real-time Systems, Time Constraints, Classification of Programs.

UNIT – II

Concepts of Computer Control: Sequence Control, Loop Control, Supervisory Control, Centralized Computer Control, Hierarchical Systems.

UNIT – III

Hardware Requirements of Real Time Systems: Introduction, General Purpose Computer, Single Chip Microcomputers and Microcontrollers, Specialized Processors, Process-Related Interfaces, Data Transfer Techniques, Communications, Standard Interface.

UNIT – IV

Operating Systems: Introduction, Real-Time Multi-Tasking OS, Scheduling Strategies, Priority Structures, Task Management, Scheduler and Real-Time Clock Interrupt Handler, Memory Management, Code Sharing, Resource Control, Task Co-Operation and Communication, Mutual Exclusion.

UNIT – V

Design of RTS: Preliminary Design. Single-Program Approach, Foreground/Background System. RTS Development Methodologies: Yow-don Methodology, Ward and Mellor Method, Hately and Pirbhai Method.

Text Books:

1. "Real-Time Computer Control", Stuart Bennet, 2nd Edition. Pearson Education, 2008.
2. "Real-Time Systems", C.M. Krishna, Kang G Shin, McGraw-Hill International Editions, 1997.

Reference Books:

1. "Real-Time Systems Design and Analysis", Phillip. A. Laplante, second edition, PHI, 2005.
2. "Embedded Systems", Raj Kamal, Tata McGraw Hill, India, third edition, 2005.

E-Books:

1. https://course.ece.cmu.edu/~ece749/docs/RTSHandbook.pdf

MOOCs:

1. https://www.coursera.org/learn/real-time-systems

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

(Autonomous College under VTU)

Course Title	APPLICATIONS OF AI				
Course Code	23EC8PE4AI	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, the student will have the ability to:

Sl. No.	Course Outcomes	POs	PSOs
CO1	Understand the principles, perspectives and ethical considerations of AI in the current technological revolution.	–	–
CO2	Analyze the utilities of AI in industrial automation, healthcare, business and education awareness.	2	1
CO3	Present a case study on emerging trends in AI and submit a technical report.	9, 10	1

UNIT – I

Artificial Intelligence: History and Applications: Introduction, Intelligence, Artificial Intelligence, Progress of Artificial Intelligence, Modeling, Simulation and AI, Intelligent Systems.

UNIT – II

Artificial Intelligence as Representation and Search: The Predicate Calculus: Introduction, the propositional Calculus, the predicate calculus, Using Inference rules to produce predicate calculus expressions, Application: A logic based financial Advisor Structure and Strategies for State Space Search: Introduction, Graph Theory, Strategies for State Space Search, Using the state space to represent reasoning with predicate calculus.

UNIT – III

Heuristic Search and Stochastic Methods: Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, the best fit search algorithm, admissibility, monotonicity and Informedness, Using Heuristics in Games, Complexity Issues Stochastic Methods: Introduction, the elements of counting, elements of probability theory, applications of stochastic methodology, bayes theorem, Recursion-based search.

UNIT – IV

Expert Systems: Introduction, expert systems, features, Characteristics, Architecture, Basic Activities, Advantages, Difference between Expert systems and conventional methods, Stages in development of an expert system, building of a rule based expert system, Machine learning expert system, Probability based expert system.

UNIT – V

Introduction to Genetic Algorithm and Swarm Intelligence: Introduction, Genetic Algorithms, Procedure of Genetic Algorithms Introduction to swarm intelligence, importance of ant colony paradigm, ant colony systems, development of ant colony system.

Text Books:

1. "Artificial Intelligence, Structures and Strategies for Complex Problem Solving", George F Luger, Fifth edition, Pearson Education.
2. "Artificial Intelligence and Intelligent Systems", N P Padhy, Oxford Publication, 2017.

Reference Books:

1. "Artificial Intelligence - A Modern Approach", Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2014.
2. "Introduction to Artificial Intelligence and Expert Systems", Dan W Patterson, Pearson, 2015.

E-Books:

1. https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf

MOOCs:

1. https://onlinecourses.nptel.ac.in/noc23_cs92/preview

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

(Autonomous College under VTU)

Course Title	DATABASE SECURITY AND ACCESS CONTROL				
Course Code	23EC8PE4DS	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, the student will have the ability to:

Sl. No.	Course Outcomes	POs	PSOs
CO1	Understand the fundamentals of database security and various access control techniques mechanisms introduced along with application areas of access control techniques	–	–
CO2	Apply database security and various access control techniques mechanisms to understand the concepts for the given parameters	1	2
CO3	Analyse database security and various access control techniques mechanisms for the given applications	2	2

UNIT – I

Introduction to Access Control: Purpose and fundamentals of access control, brief history, Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non-Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.

UNIT – II

Role-Based Access Control (RBAC): Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.

UNIT – III

Biba's integrity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi-line Insurance Company.

UNIT – IV

Smart Card based Information Security: Smart card operating system fundamentals, design and implantation principles, memory organization, smart card files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

UNIT – V

Recent trends in Database security and access control mechanisms. Case study of Role Based Access Control (RBAC) systems. Recent Trends related to data security management, vulnerabilities in different DBMS.

Reference Books:

1. "Role Based Access Control", David F. Ferraiolo, D. Richard Kuhn, Ramaswamy Chandramouli.
2. `http://www.smartcard.co.uk/tutorials/sct-itsc.pdf` : Smart Card Tutorial.

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

(Autonomous College under VTU)

Course Title	APPLICATIONS OF MIXED REALITY				
Course Code	23EC8PE4MR	Credits	3	L – T – P	3:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Learning Outcomes:

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

Sl. No.	Course Outcomes	POs	PSOs
CO1	Distinguish between AR/VR/MR and evaluate the use cases	–	–
CO2	Apply the Manipulation tasks and techniques to AR/VR systems	1	2
CO3	Analyze the wayfinding and MR strategies in AR/VR	2	2

UNIT – I

Introduction to Extended Reality (AR/VR/MR): Definition and key differences between AR, VR, and MR, Applications and use cases of AR/VR/MR technologies, Historical overview and evolution of AR/VR/MR, Immersion and presence, Our senses and the role of it in XR.

UNIT – II

3D Interaction Techniques – Manipulation: Introduction, Roadmap, 3D Manipulation Tasks, Canonical Manipulation Tasks, Application Specific Manipulation Tasks, Manipulation Techniques and Input Devices, Control Dimensions and Integrated Control in 3D Manipulation, Force versus Position Control, Device Placement and Form-Factor in 3D Manipulation.

UNIT – III

3D Interaction techniques & Design Guidelines: Interaction Techniques for 3D Manipulation, Classifications of Manipulation Techniques, Interacting by Pointing, Direct Manipulation: Virtual Hand Techniques, World in-Miniature Combining Techniques, Non-isomorphic 3D Rotation, Desktop 3D Manipulation, Design Guidelines.

UNIT – IV

Wayfinding: Introduction, Theoretical Foundations, Wayfinding Tasks, Types of Spatial Knowledge, Egocentric and Exocentric Reference Frames, User-Centered Wayfinding Support, Field of View, Motion Cues Multisensory Output, Presence, Search Strategies, Environment Centered Wayfinding Support, Environment Design, Artificial Cues, Evaluating Wayfinding Aids, Design Guidelines.

UNIT – V

Beyond Virtual - Mixed Reality: 3D User Interfaces for the Real World, Introduction, What Is Augmented Reality? Bringing Virtual Interfaces into the Real World, AR Interfaces as 3D Data Browsers, 3D Augmented Reality Interfaces, Augmented Surfaces and Tangible Interfaces, Tangible AR Interfaces, Design of Tangible AR, Time-Multiplexed Interaction in Tangible AR, Advantages and Disadvantages of Tangible AR, Agents in AR, Transitional AR-VR Interfaces.

Text Books:

1. "3D User Interfaces: Theory and Practice", Joseph LaViola Jr.
2. "Mixed Reality and Three-Dimensional Computer Graphics", Grigore C. Burdea, Philippe Coiffet
3. "Virtual Reality Technology", William R. Sherman, Alan B. Craig, 2nd Edition, 2006.

Online References:

1. `www.vrac.iastate.edu`
2. `www.w3.org/MarkUp/VRM`

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

(Autonomous College under VTU)

Course Title	LOW POWER VLSI				
Course Code	23EC8PE4LV	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	POs	PSOs
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

CMOS Fabrication Technology, Robustness: Variability, Reliability, Scaling, Variation Sources and Impacts, Variation-Tolerant Design. Need for Low Power VLSI Chips.

UNIT – II

Sources of Power Dissipation, Dynamic Power, Dynamic Voltage and Frequency Scaling, Static Power, Short-circuit Current, Power Gating, Energy-Delay Optimization, Parallelism, Pipelining, Flow Graph Transformation, Power Management Modes.

UNIT – III

Combinational Circuit Design: Static CMOS, Ratioed Circuits, Cascode Voltage Switch logic, Dynamic Circuits, Pass-Transistor Circuits, Circuit Pitfalls.

UNIT – IV

Transistor and Gate Sizing, Equivalent Pin Ordering, Signal Gating, Logic Encoding, State Machine Encoding, Power Reduction in Clock Networks, CMOS Floating Node, Low Power Bus, Delay balancing.

UNIT – V

Adiabatic Computation, Asynchronous Circuits. Battery-Aware Systems: Battery-Driven System Design, Energy-Aware Routing, Low-Power Software Approaches: Machine-Independent Software Optimizations.

Text Books:

1. "CMOS VLSI Design: A Circuits and Systems Perspective", Neil H. E. Weste and David Harris, Pearson Education, 4th Edition, 2011, ISBN: 0-321-54774-8.
2. "Practical Low Power Digital VLSI Design", Gary Yeap, Kluwer Academic Publishers, 1998.
3. "Low-Power VLSI Circuits and Systems", Ajit Pal, Springer, 2015. ISBN 978-81-322-1936-1.

Reference Books:

1. "Low-Voltage Low-Power VLSI Subsystems", Kiat-Seng Yeo and Kaushik Roy, McGraw-Hill, 2005.
2. "Low Power Digital CMOS Design", Anantha P. Chandrakasan and Robert W. Brodersen, Kluwer Academic Publishers, 1995.
3. "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, Bangalore – 19

(Autonomous College under VTU)

Course Title	5G ENABLED IOT				
Course Code	23EC8PE45G	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, the student will have the ability to

Sl. No.	Course Outcomes	POs	PSOs
CO1	Understand the concepts, principles, and applications of IoT in the context of smart infrastructure	–	–
CO2	Apply the knowledge of IoT technologies for various sustainable systems.	1, 7	1, 2
CO3	Analyze the real-world case studies and successful implementations of IoT	2	1, 2

UNIT – I

Introduction to IoT and Smart Infrastructure: Importance of IoT in transforming infrastructure. Smart Infrastructure Overview: Introduction to smart infrastructure and its key components, Benefits, and challenges of implementing smart infrastructure, Case studies showcasing successful smart infrastructure projects.

UNIT – II

Cloud computing and data analytics in IoT for infrastructure: Edge computing: Real-time decision-making at the edge. Security and Privacy in IoT for Smart Infrastructure: Security challenges and threats in IoT, Privacy considerations and data protection in smart infrastructure, best practices, and solutions for ensuring IoT security and privacy.

UNIT – III

5G Enabled IoT Applications in Smart Cities: Introduction to Smart Cities: Role of IoT in transforming cities into smart cities, Benefits, and challenges of smart city implementations. IoT Applications in Smart City Infrastructure, Smart buildings, Smart grids. Case Studies of Smart City Implementations: Analysis of the IoT technologies and strategies implemented.

UNIT – IV

5G Enabled IoT Applications in Smart Buildings: Benefits of IoT in improving energy efficiency and occupant comfort, Challenges, and considerations in implementing smart building technologies. IoT Technologies for Smart Buildings, Smart lighting and HVAC systems. Case Studies of Smart Building Implementations.

UNIT – V

5G Enabled IoT Applications in Smart Transportation: Role of IoT in intelligent traffic management and transportation systems; Challenges and opportunities in implementing smart transportation solutions. IoT Technologies for Smart Transportation.Case Studies of Smart Transportation Implementations: Showcase of successful smart transportation projects.

Text Books:

1. "Internet of Things (A Hands-on-Approach)", Arshdeep Bahga and Vijay Madisetti.
2. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry", MaciejKranz.
3. "Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia", Anthony M. Townsend, 2023.
4. "Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", Perry Lea.

Reference Books:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, "Internet of Things", John Wiley & Sons.
2. Cuno Pfister, "Getting Started with the Internet of Things", Shroff Publisher/Maker Media.
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications.
4. Massimo Banzi, Michael Shiloh Make, "Getting Started with the Arduino", Shroff Publisher/Maker Media Publishers.

Online Material:

1. `https://www.coursera.org/specializations/internet-of-things`

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

(Autonomous College under VTU)

Course Title	**UI/UX DESIGN**				
Course Code	**23EC8PE4UX**	**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, the student will have the ability

Sl. No.	**Course Outcomes**	**POs**	**PSOs**
CO1	Understand and analyze the processes involved in creating front end and back end of applications using knowledge of aesthetics	–	–
CO2	Apply concepts of design for back-end and front end design	1	2
CO3	Analyze the features available in various tools for creating optimized design	2, 5	2

UNIT – I

Introduction: Basic broad concepts and contexts for user interfaces, basic principles of interaction theory, discuss the relationship between UI and UX, relationship between coding and designing. Roles of functionality and aesthetics in interface design, terminologies, fundamentals of graphic design in the context of interface design: language, shape, color, imagery, typography, and icons)

UNIT – II

Introduction to User Experiences: User interface design cycle: Requirement gathering, design, prototyping, evaluation. Case studies, user engagement ethics.

UNIT – III

Elementary Sketching and Wireframing: Manipulate form, color, type, and imagery to emphasize a desired user action, apply the look and feel of a mood board to a set of interface elements, design a cohesive set of interface elements demonstrating the palette of UI design skills, fundamentals of UI, heuristic, and interactive design.

UNIT – IV

Master a Design Tool: UI design and web design using Figma, Material Design, Adobe XD. Compare the technologies available, Develop an interactive UI.

UNIT – V

Introduction to Backend Development: HTML: Front end and back end full-stack developer roles, websites and web browser, HTTP examples, Introduction to HTML, CSS and JavaScript, HTML document structure, HTML tags and elements, creating a basic webpage, add images to a web page, linking documents, HTML to work with data in tables.

Reference Books:

1. "The Design of Everyday Things", Don Norman, 2013.
2. "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics", Jennifer Robbin, Fourth Edition, O'REILLY.

Links for Software:

1. Figma: `https://www.figma.com/`
2. Adobe XD: `https://www.adobe.com/uk/products/xd`

MOOCs:

1. Visual Elements of User Interface Design, California Institute of the Arts, Coursera
2. Introduction to Backend Development, Coursera

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

(Autonomous College under VTU)

Course Title	AUTOMOTIVE ELECTRONICS				
Course Code	23EC8OE3AE	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	POs	PSOs
CO1	Apply the knowledge of engineering and science to analyze the performance of Electronic Engine Control, working of sensors and actuators.	1	3
CO2	Analyze the Vehicle Level Electronic Control for Automotive Subsystems.	2	3
CO3	Gain insight about building future automotive subsystems that contributes to the safety and health of the society using block diagram approach.	6	3

UNIT – I

Automotive Fundamentals Overview: Evolution of Automotive Electronics, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Starting system.

UNIT – II

Electronic Engine Control: Motivation for Electronic Engine Control, Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of Engine performance terms, Effect of Air/Fuel ratio, spark timing and EGR on performance, Electronic Fuel control system.

UNIT – III

Automotive Sensors and Actuators: Typical Electronic Engine Control System, Variables to be measured Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall Effect Position Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor, Engine Coolant Temperature Sensor, Exhaust Gas Oxygen, Knock Sensor.

Automotive Actuators: Solenoid, Fuel Injector, EGR Actuator, Ignition Actuator.

UNIT – IV

Automotive Diagnostics and Safety Systems: Timing Light, Engine Analyzer, On-board diagnostics, off board diagnostics, Air Bag systems, Antilock Brake System, Collision Avoidance Radar Warning Systems, Low tire pressure warning system, Advanced Cruise Control, Automatic driving Control.

Overview of Automotive Network Protocols: CAN, LIN, MOST and Flex Ray.

UNIT – V

Electric and Hybrid Electric Vehicles: Configuration of Electric Vehicles, Performance of Electric Vehicles, Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.

Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation.

Text Books:

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, SAMS/ Elsevier Publishing.
2. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2005.
3. Robert Bosch Gmbh (Ed.), "Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive", 5th edition, John Wiley & Sons Inc., 2007.

Reference Books:

1. "Automotive Electronics Handbook", Ronald K. Jurgen, 2nd Edition.

E-References:

1. https://www.pdfdrive.com/AutomotiveElectronicsHandbooke195167204.html
2. https://www.vlab.co.in/

E-Learning:

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

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

(Autonomous College under VTU)

Course Title	APPLICATIONS OF ROBOTICS				
Course Code	23EC8OE3AR	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, the student will have the ability

Sl. No.	Course Outcomes	POs	PSOs
CO1	Analyze and Apply fundamentals of Robotics, components and Systems for applications	1	2
CO2	Analyze and Apply concepts used in Robotics systems	2	2
CO3	Develop Solutions for building Robotic Systems meeting the specifications for a particular application	3	2

UNIT – I

Introduction to Robotics: Robot Usage, Industrial Robots and Their Applications: Robot Subsystems, Classification of Robots, Industrial Applications. Robot Architecture, Pose of a Rigid Body, DOF. Case Study: A Pick-and-place robot.

UNIT – II

Humanoid Robotics: Introduction, ASIMO and Humanoid Robot Research at Honda-Mobility, Creation of Mobile Entities that Embody New Value, Mobility Capabilities (bipedal walking, walking to running), Task Performing Capabilities, Communication Capabilities (voice, image and physical recognition), From Automatic to Autonomous (sensing, situation estimation, behavior generation, field experiments).

UNIT – III

Drone Robotics: Smart Agriculture Using UAV and Deep Learning, Introduction, Background Details, State-of-the-Art Literature Study: Plant, Smart Pest, and Herb Control use cases, Field Analysis and Yield Estimation, Discussion and Future Scope. IoT-Enabled Unmanned Aerial Vehicle: An Emerging Trend in Precision Farming, Introduction to IoT Enabled UAV, Drones in Precision Farming, Challenges & Future Scope.

UNIT – IV

Medical Robotics: Introduction, Robots for Navigation, Movement Replication, Robots for Imaging, Rehabilitation and Prosthetics, Applications of Surgical Robotics: Radiosurgery, Orthopedic Surgery, Urologic Surgery and Robotic Imaging, Cardiac Surgery, Neurosurgery, Control Modes, Developing Lightweight Robot-Arm of Anthropomorphic Characteristics: State of the Art, Industrial Lightweight Robot-Arms, Bi-Manual Robotic Systems, Concept, Design and Control of Robot Arm, Case Study.

UNIT – V

Collaborative Robotics: Introduction, Collaborative Robots: The Cobot Big Challenges, Types of Collaborations with Humans, Interaction Implementations Modes with Cobots, Safety Guidelines for Cobots, Safety vs Performance, Design Considerations for Future Cobots: Weight Reduction, Sensitive Joints Design, all other aspects, Industrial Applications: Use Cases: Electronic Panels Assembly, Domestic Appliances Assembly, Food Products Packaging.

Text Books:

1. "Introduction to Robotics", S K Saha, McGraw Hill Education (India) Private Limited, 2nd Edition, 2014.
2. "Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering", William Bolton, Pearson 7th Edition, 2019.
3. "Humanoid Robotics: A Reference", Ambarish Goswami and Prahlad Vadakkepat, Springer, Dordrecht, 2019.
4. "Internet of Things, Robotic and Drone Technology", Edited by Nitin Goyal, Sharad Sharma, Arun Kumar Rana, Suman Lata Tripathi, CRC Press, 2022.
5. "Drone Technology Future Trends and Practical Applications", Edited by Sachi Nandan Mohanty, J.V.R. Ravindra, G. Surya Narayana, Chinmaya Ranjan Pattnaik, Y. Mohamed Sirajudeen, Scrivener Publishing LLC, Wiley, 2023.
6. "Medical Robotics", Achim Schweikard, Floris Ernst, Springer International Publishing, Switzerland, 2015.
7. "New Trends in Medical and Service Robots, Assistive, Surgical and Educational Robotics", Hannes Bleuler, Mohamed Bouri, Francesco Mondada, Doina Pisla, Aleksandar Rodić, Springer International Publishing, Switzerland, 2016.
8. "Industrial Robots Design, Applications and Technology", Edited by Isak Karabegovć and Lejla Banjanović-Mehmedović, Nova Science Publishers Inc., 2020.

Reference Books:

1. "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://onlinecourses.nptel.ac.in/noc20_de11/preview`
2. `https://www.my-mooc.com/en/categorie/robotics`

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

(Autonomous College under VTU)

Course Title	IOT FOR STRUCTURES				
Course Code	23EC8OE3IS	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, the student will have the ability to

Sl. No.	Course Outcomes	POs	PSOs
CO1	Apply the knowledge of various IoT aspects (sensors, actuators, processing, technologies) and characteristics to evolve solutions related to applications and architectures.	1	1, 2
CO2	Analyze, compare, and Identify Technologies and Protocols (including adaptations)	2	1, 2
CO3	Design Solutions encompassing systems, hardware, and software aspects for various categories of problems with IoT in context.	3	1, 2
CO4	Research various domains of IoT application and provide analysis, interpret data where available, and provide recommendations.	4, 6, 9, 10	1, 2

UNIT – I

Fundamentals of IoT: What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, IoT Challenges, IoT Network Architecture and Design, Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects.

UNIT – II

IoT Protocols: Sensor Networks, WSNs, Communication Protocols for WSNs, Connecting Smart Objects, Communications Criteria, IoT Access Technologies with considerations of layers, topology, and security, competitive technologies: IEEE 802.15.4, IEEE 802.15.4g, IEEE 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN and competitive technologies, NB-IoT, other LTE variations, and competitive technologies.

UNIT – III

IP and Application Protocols: 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

IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Installation and Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi, Board Hardware Layout, OS, Configuring and 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.

UNIT – V

Applications: Transportation, Transportation Challenges, IoT Use Cases for Transportation, An IoT Architecture for Transportation, Mining Today and Its Challenges, Challenges for IoT in Modern Mining, An IoT Strategy for Mining, An Architecture for IoT in Mining.

Text Books:

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

Reference Books:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. (ISBN: 978-8173719547).
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 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 can be supplemented by project based learning.

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

(Autonomous College under VTU)

Course Title	MOBILE TECHNOLOGY AND APPLICATIONS				
Course Code	23EC8OE3MT	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, the student will have the ability to

Sl. No.	Course Outcomes	POs	PSOs
CO1	Understand the basics of wireless and Mobile Technology	–	–
CO2	Apply the knowledge of Mobile Technology for various wireless networks	1	1
CO3	Investigate Mobile based applications through literature survey and use cases	2, 5	1

UNIT – I

Wired and Wireless communication-difference, Introduction to mobile communication, spectrum allocation, services, and range of operation. Mobile phone block description, WiFi, Bluetooth.

UNIT – II

Evolution of Mobile communication from 2G to 4G, Cellular Concepts, basic cellular GSM architecture, Frequency reuse, Channel assignment strategies, Capacity expansion methods, Call establishment, Mobile service providers.

UNIT – III

Migration towards 4G mobile technology, LTE features and applications, Features of 5G and its applications. Mobile IP architecture and its elements, Emerging Wireless networks (WLAN) and its components, wireless Sensor networks (block description).

UNIT – IV

Applications of mobile technology: M-commerce framework, Different players, lifecycle, Different Mobile commerce applications and services, content development and distribution, technologies, standard bodies.

UNIT – V

Use of mobile technology in healthcare: devices and wearable technology. Agricultural applications, mobile based financial transactions and payments, Entertainment and education services. Case studies on Rural Wireless Telemedicine System, digital currency and Financial Sustainability of Village, Applications of Mobile Technology in the Industrial scenario, Utilising Mobile Devices for Data Collection and Analysis

Text Books:

1. "Wireless Communication", Andreas F. Molish, Wiley, 2nd Edition.
2. "Mobile Commerce: Technology, Theory and Applications", Brian Mennecke and Troy J. Strader, Idea Group Publishing.

Reference Books:

1. "Wireless Communications: Principle and Practice", Theodore S. Rappaport, Prentice Hall, 2005.

E-Resource:

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. https://www-mooc--list-com.webpkgcache.com/doc/-/s/www.mooc-list.com/tags/mobile-applications
2. https://www.coursera.org/courses?query=smartphone%20emerging%20technologies

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

(Autonomous College under VTU)

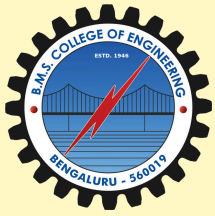
Course Title	**INTERNSHIP**				
Course Code	**23EC8SRINT**	**Credits**	**6**	**L – T – P**	**0:0:6**
CIE	**50 Marks (100% weightage)**		**SEE**	**50 Marks (100% weightage)**	

Course Outcomes:

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

Sl. No.	**Course Outcomes**	**PO**	**PSO**
CO1	Develop awareness and apply conceptual domain knowledge to address global and contemporary issues in engineering and technology including project management and finance	1, 11	1, 2, 3
CO2	Identify the industrial problem with proper synthesis of information analyse the specific needs and acquire appropriate skillset.	2, 4, 5	1, 2, 3
CO3	Propose sustainable solution/system for the betterment of the society	3, 6, 7	1, 2, 3
CO4	Engage in independent and lifelong learning follow professional ethics and communicate effectively	8, 9, 10, 12	1, 2, 3

NOTE: Each student has to earn 100 AICTE Activity Points during 1st to 8th semester. Lateral-entry students are required to earn 75 AICTE Activity Points during 3rd to 8th semester.



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