Avinashilingam Institute for Home Science and Higher Education for Women

(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with 'A++' Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

School of Engineering

B.E. Electronics and Communication Engineering

Programme Specific Outcomes:

PSO1: Design and implement electronic systems for real time applications including Communication systems, Signal Processing,VLSI and Embedded systems.

PSO2: Analyse and solve complex Electronics and Communication Engineering problems, using latest hardware and Software tools either independently or in a team.

Scheme of Instruction & Examination

(For students admitted from the academic year **2024-2025** and onwards)

Part	*Course Code*	*Name of Course/component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credit*
First Semester									
Induction Program including Universal Human Values (Introduction)									
I		**Humanities and Social Sciences (HS)**							
	24BEHS01	English for Technical Writing	2	0/2	3	50	50	100	3
II		**Basic Sciences (BS)**							
	24BESM01	Mathematics - I (Algebra and Calculus)	3	1/0	3	50	50	100	4
	24BESP02	Physics - Oscillation, Waves and Optics	3	0/2	3	50	50	100	4
III		**Core Courses** **Engineering Sciences (ES)**							
	24BEES01	Basic Electrical and Electronics Engineering	3	0/2	3	50	50	100	4
	24BEES02	Programming for Problem Solving using C (CSE)	3	-	3	50	50	100	3
	24BEES05	Programming for Problem Solving using C Laboratory (CSE)	-	0/2	3	50	50	100	1
	24BEES06	Engineering Practices Laboratory	-	0/4	3	50	50	100	2
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC01	Environmental Science	3	-	2	100	-	100	Remark
	24EVBNS1/ 24EVBNC1/ 24EVBSP1	Value Based Elective - I NSS-I/NCC-I/Sports-I	-	-	2	100	-	100	Remark
		Second Semester							
I		**Humanities and Social Sciences (HS)**							
	24BEHS02	Universal Human Values -II (Understanding Harmony and Ethical Human Conduct)	2	1/0	3	50	50	100	3
II		**Basic Sciences (BS)**							
	24BESM02	Mathematics-II (Laplace Transforms and Complex Variables)	3	1/0	3	50	50	100	4
	24BESC01	Applied Chemistry	3	0/2	3	50	50	100	4
III		**Core Courses** **Engineering Sciences (ES)**							
	24BEES08	Computer Aided Engineering Graphics (CIVIL)	2	0/3	3	50	50	100	3
	24BEES09	Programming for Problem Solving using Python (CSE)	3	-	3	50	50	100	3
	24BEES10	Electric Circuit Analysis	3	-	3	50	50	100	3
	24BEES13	Programming for Problem Solving using Python Laboratory(CSE)	-	0/2	3	50	50	100	1
	24BEES14	Electric Circuit Analysis Laboratory	-	0/2	3	50	50	100	1
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC02	Constitution of India	2	-	2	100	-	100	Remark
	24EVBNS2/ 24EVBNC2/ 24EVBSP2	Value Based Elective-I NSS-II/NCC-II/Sports-II	-	-	2	100	-	100	Remark

Part	*Course Code*	*Name of course/component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credits*
Third Semester									
II		**Basic Sciences (BS)**							
	24BESM07	Mathematics-III (Partial Differential Equations and Numerical Techniques)	3	-	3	50	50	100	3
III		**Core Courses Engineering Sciences (ES)**							
	24BEES18	C++ and Data Structures (CSE)	3	-	3	50	50	100	3
		Core Courses Professional Core (PC)							
	24BELC01	Electronic Devices and Circuits	3	-	3	50	50	100	3
	24BELC02	Signals and Systems	3	-	3	50	50	100	3
	24BELC03	Digital System Design	3	-	3	50	50	100	3
	24BELC04	Networks and Transmission Lines	3	-	3	50	50	100	3
	24BELC05	Electronic Devices and Circuits Laboratory	-	0/3	3	50	50	100	1
	24BELC06	Digital System Design Laboratory	-	0/3	3	50	50	100	1
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC03	Consumer Affairs	3	-	2	100	-	100	Remark
	24BELV01	Value Added Course – Embedded System for Beginners	2	-	2	100	-	100	Remark
Fourth Semester									
I		**Basic Sciences (BS)**							
	24BESM10	Mathematics-IV (Probability and Stochastic Processes)	3	1/0	3	50	50	100	4
III		**Core Courses Professional Core (PC)**							
	24BELC07	Linear Integrated Circuits	3	-	3	50	50	100	3
	24BELC08	Electromagnetic Fields	3	-	3	50	50	100	3
	24BELC09	Microprocessors and Microcontrollers	3	0/2	3	50	50	100	4
	24BELC10	Computer Networks and Security	3	-	3	50	50	100	3
	24BELC11	Analog and Digital Communication	3	-	3	50	50	100	3
	24BELC12	Linear Integrated Circuits Laboratory	-	0/3	3	50	50	100	1
	24BELC13	Analog and Digital Communication Laboratory	-	0/3	3	50	50	100	1
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC04	Essence of Indian Knowledge Tradition	3	-	2	100	-	100	Remark
	24BECS01	Communication Skills	2	-	2	100	-	100	Remark
		# 6 to 8 weeks Industrial Internship during summer vacation							

Part	*Course Code*	*Name of Course/ component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credits*
Fifth Semester									
III		**Core Courses** **Professional Core (PC)**							
	24BELC14	Digital Signal Processing	3	1/0	3	50	50	100	4
	24BELC15	Computer Architecture and Organization	3	-	3	50	50	100	3
	24BELC16	Control Systems	3	-	3	50	50	100	3
	24BELC17	Embedded Systems	3	-	3	50	50	100	3
	24BELC18	Antennas and Wave Propagation	3	0/2	3	50	50	100	4
	24BELC19	Digital Signal Processing Laboratory	-	0/3	3	50	50	100	1
	24BELC20	Embedded Systems Laboratory	-	0/3	3	50	50	100	1
		Professional Elective (PE)							
		Professional Elective – I (PE1 or PE2)	3	-	3	50	50	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC05	Design Thinking	1	0/2	2	100	-	100	Remark
	24BESS01	Soft Skills	2	-	2	100	-	100	Remark
Professional Elective-I (Select one course either from PE1 or PE2)									
PE1: 24BELE01 Advanced Digital System Design/ 24BELE02 Electronic Measurements and Instrumentation/ 24BELE03 Quantum Electronics/ 24BELE04 Nano and Flexible Electronics			**PE2:** 24BELE21 Fundamentals of IoT/ 24BELE22 Operating Systems/ 24BELE23 Programming Languages/ 24BELE24 Digital Switching Systems						
Sixth Semester									
III		**Core Courses** **Professional Core (PC)**							
	24BELC21	VLSI Design	3	-	3	50	50	100	3
	24BELC22	Artificial Intelligence and Machine Learning	3	-	3	50	50	100	3
	24BELC23	Mobile Communication and Networks	3	-	3	50	50	100	3
	24BELC24	Microwave and Optical Communication	3	-	3	50	50	100	3
	24BELC25	VLSI Design Laboratory	-	0/3	3	50	50	100	1
	24BELC26	Microwave and Optical Communication Laboratory	-	0/3	3	50	50	100	1
	24BELC27	Mini Project	-	0/4	-	100	-	100	2
		Professional Electives (PE)							
		Professional Elective – II (PE1 or PE2)	3	-	3	50	50	100	3
	24BELE40 - 24BELE59	Professional Elective – III(PE1 or PE2) Title of MOOC (SWAYAM-NPTEL) ##	3	-	-	-	100	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC06	Professional Ethics	3	-	2	100	-	100	Remark
	24BVBAP1/ 24BVBGP1/ 24BVBWS1/ 24BSCGA1/ 24BSCQA1	Value Based Elective-II	-	-	2	100	-	100	Remark
# 6 to 8 weeks Industrial Internship during summer vacation									
Professional Elective-II (Select one course from PE1 if the student selected PE1 in 5th semester or select one course from PE2 if the student selected PE2 in 5th semester)									
PE1: 24BELE05 Advanced Digital Signal Processing/ 24BELE06 Advanced Digital Communication/ 24BELE07 Smart Antennas/ 24BELE08 Satellite Communication			**PE2:** 24BELE25 Printed and Wearable Electronics/ 24BELE26 Embedded OS and RTOS/ 24BELE27 Wireless Sensor Networks/ 24BELE28 Deep Learning						

Professional Elective-III

One MOOC (12 weeks duration) through SWAYAM - NPTEL with credit transfer of 3 credits, as an alternative to Professional Elective - III in VI Semester which should be completed between 3rd and 7th semester. Title of the MOOC to be specified after enrollment.

Part	Course Code	Name of Course/component	Hours of Instruction/week		Scheme of Examination				
			Theory	Tutorial/ Practical	Duration of exam	CIA	CE	Total	Credits
Seventh Semester									
I		**Humanities and Social Sciences (HS)**							
	24BEHS09	Principles of Management and Economics	3	-	3	50	50	100	3
III		**Core Courses** **Professional Core (PC)**							
	24BELC28	Digital Image Processing and Computer Vision	3	-	3	50	50	100	3
	24BELC29	Digital Image Processing and Computer Vision Laboratory	-	0/3	3	50	50	100	1
	24BELC30	Industrial Internship[#]	-	-	3	100	-	100	2
	24BELC31	Project Work - Phase I	-	0/4	-	100	-	100	2
		Professional Electives (PE)							
		Professional Elective – IV (PE1 or PE2)	3	-	3	50	50	100	3
	24BELE60 - 24BELE79	Professional Elective – V (PE1or PE2) Title of MOOC (SWAYAM-NPTEL) ##	3	-	-	-	100	100	3
		Open Electives (OE)							
	24BEVO01/ 24BEOO01/ 24BEBO01/ 24BEFO01/ 24BEPO01	Open Elective -1	3	-	3	50	50	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC07	Disaster Management	3	-	2	100	-	100	Remark
	24BEML01	Electronics and Communication Engineering - Computer Based Test (CBT)	-	-	2	100	-	100	Remark

Professional Elective-IV (Select one course from PE1 if the student selected PE1 in 5th & 6th semesters or select one course from PE2 if the student selected PE2 in 5th & 6th semesters)

PE1:	**PE2:**
24BELE09 Low power VLSI Design/	24BELE29 5G Communication in IoT/
24BELE10 Electronic Product Design/	24BELE30 Data Science for IoT/
24BELE11 RF System Design/	24BELE31 Sensors and Actuators/
24BELE12 FPGA Based System Design	24BELE32 Industry 4.0 and Industrial IoT

Professional Elective-V

One MOOC (12 weeks duration) through SWAYAM - NPTEL with credit transfer of 3 credits, as an alternative to Professional Elective - V in VII Semester which should be completed between 3rd and 7th semester. Title of the MOOC to be specified after enrollment.

Open Elective - I

24BEVO01 Vaastu Shastra and Remedial Vaastu/
24BEOO01 Open Source Technologies/
24BEBO01 IoT for Personal Healthcare /
24BEFO01 Fundamentals of Food Process Engineering/
24BEPO01 3D Printing Techniques

Part	Course Code	Name of Course/component	Hours of Instruction/week		Scheme of Examination				
			Theory	Tutorial/ Practical	Duration of exam	CIA	CE	Total	Credits
Eighth Semester									
III		**Core Courses** **Professional Core (PC)**							
	24BELC32	Project Work - Phase II	-	0/20	-	100	100	200	10
		Open Electives (OE)							
	24BEVO02/ 24BEOO02/ 24BEBO02/ 24BEFO02/ 24BEPO02/	Open Elective - II	3	-	3	50	50	100	3

Part	*Course Code*	*Name of Course/component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credits*
	24BEVO03/ 24BEOO03/ 24BEBO03/ 24BEFO03 24BEPO03	Open Elective - III	3	-	3	50	50	100	3

Open Elective - II	**Open Elective-III**
24BEVO02 Real Estate Practices/ 24BEOO02 Cyber Laws and Security Policies/ 24BEBO02 Telehealth Technology / 24BEFO02 Principles of Nutrition/ 24BEPO02 Cross Media Publishing Techniques	24BEVO03 Green Building Concepts/ 24BEOO03 Introduction to Data Analytics/ 24BEBO03 Diagnostic Instrumentation/ 24BEFO03 Food Preservation Technology/ 24BEPO03 Multimedia Development

Total Credits	**165**

Semester	*Course Code*	*Name of Course/component*	*Hours of Instruction/ week / Course*	*Credit/ Course*
Part – IV Non-Credit Mandatory Courses (NCMC)				
	A. Ability Enhancement Compulsory Courses (AECC)			
1	24BEMC01	Environmental Science	3	Remark
2	24BEMC02	Constitution of India	2	
3	24BEMC03	Consumer Affairs	3	
4	24BEMC04	Essence of Indian Knowledge Tradition	3	
4	24BECS01	Communication Skills	2	
5	24BEMC05	Design Thinking	3	
5	24BESS01	Soft Skills	2	
6	24BEMC06	Professional Ethics	3	
7	24BEMC07	Disaster Management	3	
	B. Skill Enhancement Courses (SEC)			
3	24BELV01	**Value Added Course** Embedded System for Beginners	40 hrs. duration	Remark
	C. Value Based Elective- I			
1-2	24EVBNS 1-2/ 24EVBNC 1-2/ 24EVBSP 1-2	NSS I & II / NCC I & II / Sports I & II (Representing the Institute)	-	Remark
	Value Based Elective-II			
6	24EVBAP1/ 24EVBGP1/ 24EVBWS1/ 24BSCGA1/ 24BSCQA1	Principles of Dr.Ambedkar's Philosophy / Gandhian Philosophy / Women Empowerment Perspective in the Current Scenario / General Awareness / Quantitative Aptitude	Varied duration	Remark
	D. Computer Based Test (CBT)			
7	24BEML01	Electronics and Communication Engineering	-	Remark

Minimum credits required to earn the B.E. degree: 165

Requirements to earn the B.E. degree:

1. Total credits to be earned in Part I, II & III components: 165
2. Successful completion of Part IV Non–Credit Mandatory Courses (NCMC).
3. Minimum of two 3 credit (12 weeks duration) MOOCs to be completed through SWAYAM–NPTEL as an alternative to two Professional Electives, Elective III & Elective V ($^{\#\#}$with credit transfer)
4. #6 to 8 weeks Industrial Internship during 4th and /or 6th semester during summer vacation.

List of Professional Electives (PE1) Communications, VLSI and Networks Domain

Part	*Semester*	*Course Code*	*Name of Course/component*
III	**V Professional Elective - I**	24BELE01	Advanced Digital System Design
		24BELE02	Electronic Measurements and Instrumentation
		24BELE03	Quantum Electronics
		24BELE04	Nano and Flexible Electronics
	VI Professional Elective - II	24BELE05	Advanced Digital Signal Processing
		24BELE06	Advanced Digital Communication
		24BELE07	Smart Antennas
		24BELE08	Satellite Communication
	VI Professional Elective - III	24BELE40 - 24BELE49	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
	VII Professional Elective - IV	24BELE09	Low power VLSI Design
		24BELE10	Electronic Product Design
		24BELE11	RF System Design
		24BELE12	FPGA Based System Design
	VII Professional Elective - V	24BELE60 - 24BELE69	**MOOC (12 Weeks Course in SWAYAM – NPTEL**

List of Professional Electives (PE2) IoT Domain

Part	*Semester*	*Course Code*	*Name of Course/component*
III	**V Professional Elective - I**	24BELE21	Fundamentals of IoT
		24BELE22	Operating Systems
		24BELE23	Programming Languages
		24BELE24	Digital Switching Systems
	VI Professional Elective - II	24BELE25	Printed and Wearable Electronics
		24BELE26	Embedded OS and RTOS
		24BELE27	Wireless Sensor Networks
		24BELE28	Deep Learning
	VI Professional Elective - III	24BELE50 - 24BELE59	**MOOC (12 Weeks Course in SWAYAM – NPTEL**
	VII Professional Elective - IV	24BELE29	5G Communication in IoT
		24BELE30	Data Science for IoT
		24BELE31	Sensors and Actuators
		24BELE33	Industry 4.0 and Industrial IoT
	VII Professional Elective - V	24BELE70 - 24BELE79	**MOOC (12 Weeks Course in SWAYAM – NPTEL**

Open Electives offered by the Department

Part	*Semester*	*Course code*	*Name of course/Component*
III	VII	24BELO01	Sensors
	VIII	24BELO02	Drone Technologies
	VIII	24BELO03	IoT in Connected Cars

Remarks for NCMC Courses

Range of Marks	*Remark*
90-100	Excellent
75-89	Very Good
60-74	Good
40-59	Fair
Less than 40	Not Completed

B.E. Honours (Internet of Things) (OPTIONAL)

Part	*Semester*	*Course Code*	*Name of Course/component*
III	V	24BELH01	Energy Harvesting Technologies and Power Management for IoT Devices
		24BELH02	Privacy and Security in IoT
	VI	24BELH03	Cognitive IoT
		24BELH04	Communication Technologies for IoT
	To be completed between 5th to 7th semesters	24BELH51/ - 24BELH60	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
		24BELH61/ - 24BELH70	**MOOC (12 Weeks Course in SWAYAM – NPTEL**

Minor Specialization (Wearable Technology) (OPTIONAL)

Part	*Semester*	*Course Code*	*Name of Course/component*
III	**V**	24BELE04	Nano and Flexible Eletronics
		24BELE27	Wireless Sensor Networks
	VI	24BELE25	Printed and Wearable Electronics
		24BELE31	Sensors and Actuators
	To be completed between 5th to 7th semesters	24BELM01/ - 24BELM10	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
		24BELM11/ - 24BELM20	**MOOC (12 Weeks Course in SWAYAM – NPTEL**

English for Technical Writing

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of instruction/week: 2T+2P**

24BEHS01 **No. of credits: 3**

Course Learning Objectives:

CLO1: Comprehension of spoken and written deliberations

CLO2: Presentation in academic and professional situations

CLO3: Employability skills needed for job interviews and placement

Unit I Introduction to Technical writing 6

Technical Vocabulary/ Jargon, Word formation, Impersonal passive voice, Tenses, use of prepositions, 'if clauses', subject verb agreement, Editing, British and American English.

Unit II Internal & External Communications 6

Writing instructions and recommendations, Data interpretation, Paragraph writing, Formal letters-writing to officials (seeking permission for practical training, asking for Certificates, testimonials, calling for quotation, purchase letter, complaint letter) & Resume writing, Report Writing, E-mail writing, Framing Agendas, Minutes of the meeting.

Unit III Creative Writing 6

Designing an Advertisement, Interpreting advertisements, Slogan/caption writing, creating one's own advertisement for a product, writing blog and on social media platforms, apply best practices of technical writing to assessing new communications contexts and describing the ethical and safety issues regarding communication and the Internet.

Unit IV Speaking Skills 6

Group Discussion - GD strategies, initiating a discussion, persuasion skills, body language, ways of interrupting (non–offending), summarizing and concluding. Self-introduction, Interview skills & Mock interview.

Unit V Presentation Skills 6

Business and technical presentation, writing summary after reading articles from journals – Format for journal, articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references)

Total Hours: 30

List of Experiments:

1. Vocabulary enrichment – Word Formation
2. Justifying and Summarizing Skills – GRE, TOTEL &IELTS
3. Composing E-mails
4. Designing an advertisement
5. Self-Introduction
6. Group discussion
7. Mock Interview
8. Technical Presentation
9. Book Review
10. Public Speaking Skills

Total Hours: 30

References:

1. ***Bhushun Kumar Kul (2022)***. ***English for Technical Professionals with lab manual,*** Khanna Books Publishing Co (P) Ltd.
2. ***Hamlin Annemarie & Rubio Chris (2016).*** Central Oregon Community College, **Technical Writing**: Open Oregon Educational Resources: ISBN 13: 9781636350653 (Creative Commons Attribution Non Commercial Share Alike)
3. ***S.Sumant (2017). English for Engineers***. Tata Mcgraw Hill Education Private Limited: ISBN13: 978-8182091399.
4. ***Cindy*** **Leaney** ***(2007). Dictionary Activities***. Cambridge University Press.
5. ***Shreesh Chaudhary (2007) Better Spoken English***. Vikas Publishing House Pvt Ltd.

Course Outcomes:

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

CO 1: Construct organized academic and professional writing.

CO 2: Achieve proficiency in the effective use of language in various authentic career, related situations.

CO 3: Communicate effectively in different situations by using specific, technical vocabulary.

CO 4: Speak convincingly, express their opinions clearly, initiate a discussion, negotiate and argue using appropriate communicative strategies.

CO 5: Employ skills to face interviews and technical presentation skills.

CO-PO MAPPING

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

Mathematics – I (Algebra and Calculus)

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction/week: 3T+1Tu**
24BESM01 **No. of Credits: 4**

Course Learning Objectives:

CLO1: To develop skills in processing matrices and applications of differential calculus

CLO2: To enrich knowledge in solving problems in multiple integrals and ordinary Differential equations

Unit I Matrices **12**

Rank of a matrix – Consistency of a system of linear equations – Solution of a system of linear equations - Characteristic equation of matrix - Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors - Cayley Hamilton theorem

Unit II Orthogonal Matrices **9**

Orthogonal matrices – Orthogonal transformation of a symmetric matrix - Reduction of quadratic form to canonical form by orthogonal transformation.

Unit III Functions of Several Variables **12**

Total derivative – Taylor's series expansion - Maxima and minima - Constrained maxima and minima by Lagrangian multiplier - Jacobians.

Unit IV Multiple Integrals **12**

Double integration – Cartesian and polar coordinates –Change of order of integration – Area as a double integral - Triple integration in cartesian coordinates and spherical polar coordinates - Volume as a triple integral.

Unit V Ordinary Differential Equations **15**

Linear equations of second order with constant coefficients and variable coefficients (Homogeneous equations of Euler type) - Method of variation of parameters - Simultaneous first order linear equations with constant coefficients.

Total hours : 60

References:

1. ***T.Veerarajan (*2016), *Engineering Mathematics (for semester I and II),*** updated 2nd Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
2. ***P.Kandaswamy, K.Thilagavathy and K.Gunavathy(2014), Engineering Mathematics, Volume I***, 10th Revised Edition, S. Chand & Co, New Delhi.
3. ***E.Kreyszig (2014), Advanced Engineering Mathematics***, 8th Edition, John Wiley and Sons (Asia) Ltd, Singapore.
4. ***Dennis G.Zill and MichaelR.Cullen(2012),Advanced Engineering Mathematics,***2nd edition, CBS Publishers.

5. ***Srimanta Pal and Subhodh C Bhunia (2012), Engineering Mathematics,*** 9th Edition, John Wiley and Sons.
6. ***Dr.B.S.Grewal(2014),Higher Engineering Mathematics***,43rdEdition,Khanna Publishers, New Delhi.
7. ***G.B.Thomas (2009), Calculus*** ,11thEdition, Pearson Education.

Course Outcomes:

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

CO1: Apply the concepts of matrices to solve problems in engineering.
CO2: Apply orthogonal transformation to reduce quadratic form of a matrix to canonical form.
CO3: Evaluate maxima and minima of a multivariable function.
CO4: Determine area and volume using multiple integrals.
CO5: Solve higher order linear ordinary differential equations.

CO-PO MAPPING

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

Physics - Oscillation, Waves and Optics

(Common to Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/Electronics and Communication Engineering)

Semester I **Hours of Instruction/week: 3T+ 2P**
24BESP02 **No. of credits: 4**

Course Learning Objectives:

CLO1: To impart knowledge in basic concepts of physics relevant to engineering and technology.

CLO2: To understand and apply the concepts of physics for various engineering applications.

CLO3: To impart experimental skills on potentially important experiments needed for Engineering.

Unit I Wave Mechanics **9**

Matter waves, De-Broglie's concept of matter waves, Properties of matter waves, Heisenberg's uncertainty principle, Schrödinger's time dependent and time independent equations, Schrödinger wave equation, Particle in one dimensional box, Electron microscope, Scanning electron microscope (SEM).

Unit II Ultrasonic Waves and Acoustics **9**

Introduction, Magnetostriction effect, Production of ultrasonic waves: Magnetostriction generator, Inverse piezoelectric effect, Piezoelectric generator, Properties, Ultrasonic Doppler Blood flow meter. Classification of sound, Weber- Fechner law, Absorption coefficient and its determination, Factors affecting acoustics of building and their remedies.

Unit III Optical Properties of Materials **9**

Photoconductive materials, Light Dependent Resistor, Working of LDR, Applications of LDR, Photovoltaic materials, Solar cell, Construction and working of a solar cell, Applications of solar cells, Liquid crystals, Liquid crystal Display(LCD), Construction and advantages of LCD.

Unit IV Lasers and Fiber optics **9**

Principle of spontaneous and stimulated emission, Einstein theory of stimulated emission, Population inversion, Pumping mechanism, Semiconductor laser, Application: holography. Fiber optics – Principle, Classification based on materials, refractive index profile, Applications: Fiber optic communication, Temperature sensor and Endoscope.

Unit V Waves and Oscillations **9**

Mechanical and electrical simple harmonic oscillators; damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator.

Total Hours: 45

List of Experiments (Any 10)

1. LASER- Wavelength & Particle size determination
2. Ultrasonic interferometer-Determination of compressibility of a liquid
3. Melde's apparatus- Frequency of the vibrator
4. Spectrometer- wavelength determination –Grating (Simulation Experiment).
5. Torsional Pendulum-Rigidity modulus of wire and Moment of inertia of disc.
6. Non Uniform bending – Determination of Young's Modulus.
7. LCR Bridge –Dielectric constant of Solids
8. Four Probe Apparatus-Band gap of a Semiconductor
9. Hysteresis curve tracer - Coercivity and Retentivity
10. Solar cell-V-I characteristics
11. Spectrometer- Determination of dispersive power of the prism.
12. Fiber optics – Numerical aperture

Total Hours: 30

References:

1. ***M.N.Avadhanulu, P.G.Kshirsagar, TVS Arun Murthy (2022). A Text Book of Engineering Physics***. S Chand Publications, New Delhi.
2. ***H.K.Malik, A.K.Singh (2021).Engineering Physics.*** McGraw Hill Education Private Limited, New Delhi.
3. ***D.R.Joshi (2010). Engineering Physics.*** McGraw Hill Education Private Limited, New Delhi.
4. ***S.O.Pillai (2014). A Textbook of Engineering Physics.*** New Age International (P) Limited, New Delhi.
5. ***B. B. Laud (2015). Lasers and Non-Linear Optics.*** New Age International Publications, New Delhi.
6. ***H.J. Pain (2013). The Physics of Vibrations and Waves.*** John Wiley and Sons.
7. ***Bhattacharya D.K and T.Poonam (2015). Engineering Physics***, Oxford University Press.

Course Outcomes:

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

CO1: Understand the importance of Wave Mechanics
CO2: Acquire the basic knowledge in Ultrasonics and Acoustics
CO3: Understand the principles of optical materials and devices for various engineering applications.
CO4: Understand the Principle and Applications of Lasers and Optical Fibers.
CO5: Identify the basic concepts of waves and oscillations in Engineering.

CO-PO MAPPING

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

Basic Electrical and Electronics Engineering

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction/week: 3T+2P**
24BEES01 **No. of credits: 4**

Course Learning Objectives:

CLO1: To impart knowledge in the basics of electrical circuits and working principles of electrical machines.

CLO2: To educate on the fundamental concepts of analog electronics, digital electronics and measuring instruments.

Unit I Electrical Circuits **9**

Circuit Components: Surface Mount Device (SMD) Components – Ohm's Law - Kirchhoff's Laws - Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state). Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power, apparent power and power factor.

Unit II Electrical Machines **9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Synchronous motor and Three Phase Induction Motor.

Unit III Basic Electronics **9**

Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type, P-N junction, VI Characteristics of PN junction diode, Zener effect, Zener diode, Zener diode Characteristics- Introduction to BJT and JFET (Construction, working and characteristics).

Unit IV Digital Electronics **9**

Review of number systems, binary codes (BCD, ASCII), Logic gates, Representation of logic functions - SOP and POS forms, Introduction to K-map representations - Minimization using K maps (Simple Problems only) – Adder and Subtractor (Half and Full) – Multiplexer, Demultiplexer.

Unit V Measurement and Instrumentation **9**

Functional elements of an instrument, Standards and calibration, Operating principle - Moving Coil and Moving Iron meters, Measurement of three-phase power, Instrument transformers - Current and Potentiometer Transformer, DSO- Block diagram.

Total Hours: 45

List of Experiments:

1. Verification of Ohms law.
2. Speed control of DC Motor by armature resistance control (Simulation).
3. Determination of transformer equivalent circuit from open circuit and short circuit test (Simulation).
4. VI characteristics of PN junction diode.
5. Voltage regulation using Zener Diode.
6. Implementation of Boolean Functions.
7. Implementation of Adder and Subtractor.
8. Study of Digital Storage Oscilloscope.

Total Hours: 30

References:

1. ***Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering",*** Second Edition, McGraw Hill Education, 2020.
2. ***S.K.Bhattacharya "Basic Electrical and Electronics Engineering",*** Pearson Education, Second Edition, 2017.
3. ***Sedha R.S., "A Textbook Book of Applied Electronics",*** S. Chand & Co., 2008
4. ***A.K. Sawhney, PuneetSawhney "A Course in Electrical & Electronic Measurements & Instrumentation"***, Dhanpat Rai and Co, New Delhi, 2021.

Course Outcomes:

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

CO1: Compute the simple electric circuit parameters.
CO2: Explain the working principle and test the electrical machines.
CO3: Analyze the characteristics of analog electronic devices.
CO4: Apply the basic concepts of digital electronics.
CO5: Explain the operating principles of measuring instruments.

CO-PO MAPPING

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

Programming for Problem Solving using C

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction /week: 3T**

24BEES02 **No. of credits: 3**

Course Learning Objectives:

CLO1: To understand the basic programming constructs for problem solving.

CLO2: To apply the basic knowledge in programming concepts and problem solving using C.

Unit I Computational Thinking and Problem Solving 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms- building blocks of algorithms (statements- state - control flow- functions)- notation (pseudo code- flow chart- programming language)- algorithmic problem solving- simple strategies for developing algorithms (iteration- recursion). Illustrative problems: find minimum in a list- insert a card in a list of sorted cards- guess an integer number in a range- Towers of Hanoi.

Unit II Introduction to C - Data types, Expressions and Statements 9

Introduction to programming paradigms – Applications of C Language - Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements- Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process- Introduction to Arrays: Declaration- Initialization – One dimensional array –Two dimensional arrays - String operations: length- compare- concatenate- copy – Selection sort- linear and binary search.

Unit III Functions and Pointers 9

Modular programming - Function prototype- function definition- function call- Built-in functions (string functions- math functions) – Recursion- Binary Search using recursive functions –Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Parameter passing: Pass by value- Pass by reference.

Unit IV Structures and Union 9

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation - Singly linked list – type def – Union - Storage classes and Visibility.

Unit V File Processing 9

Files – Types of file processing: Sequential access- Random access – Sequential access file - Random access file - Command line arguments.

Total Hours: 45

References:

1. ***Yashwant Kanetkar(2020). Let us C.***17th Edition, BPB Publications.
2. ***Byron S. Gottfried, Jitendar Kumar Chhabra (2018). Programming with C.***fourthedition, Tata McGraw Hill Publishing Company., New Delhi.
3. ***Paul Deitel and Harvey Deitel(*2018).*C How to Program with an Introduction to C+.*** Eighth edition, Pearson Education.
4. ***ReemaThareja (2016). Programming in C.*** Second Edition, Oxford University Press.
5. ***Kernighan, B.W and Ritchie, D.M (2015). The C Programming language.*** Second Edition, Pearson Education.

Course Outcomes:

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

CO1: Learn the basic algorithmic concepts used to solve simple computational problems.

CO2: Explain the basic constructs of C programming language.

CO3: Identify the importance of functions and pointers.

CO4: Differentiate the applications of structures and union.

CO5: Analyze the working of various file processing techniques.

CO-PO MAPPING

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

Programming for Problem Solving using C Laboratory

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction /week: 2P**

24BEES05 **No. of credits: 1**

Course Learning Objective:

CLO1: To understand and gain knowledge on the basic concepts in C programming language.

List of Experiments:

1. Write a C program to implement I/O Statements.
2. Write a C program to implement Operators.
3. Develop and execute a C program using Switch Case Statements.
4. Develop and execute a C program using Conditional Statements.
5. Write a C program to implement Looping Statements.
6. Develop and execute a C program for 1D & 2D-Arrays.
7. Execute a C program to perform Strings operations.
8. Write a C program to implement Functions and Recursive Functions.
9. Write a C program to implement various Parameters passing methods of Functions.
10. Write a C program to implement Structures and Unions.
11. Write a C program to implement Pointers.
12. Write a C program to implement Files.

Total Hours: 30

Software Requirements:

Turbo C

References:

1. ***Yashwant Kanetkar (2020). Let us C.***17th Edition, BPB Publications.
2. ***Byron S. Gottfried, Jitendar Kumar Chhabra (2018). Programming with C.*** *F*ourth edition, Tata McGraw Hill Publishing Company., New Delhi.
3. ***Paul Deitel and Harvey Deitel (*2018). *C How to Program with an Introduction to C+.*** Eighth edition, Pearson Education.
4. ***ReemaThareja (2016). Programming in C.*** Second Edition, Oxford University Press.
5. ***Kernighan, B.W and Ritchie, D.M (2015). The C Programming language.*** Second Edition, Pearson Education.

Course Outcomes:

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

CO1: Experiment the fundamental concepts, control statements and functions in C programming.

CO2: Apply Structures, Union, Pointers and File concepts in C Programming to provide solutions to real world applications.

CO3: Analyze real world problems and use appropriate concepts in C programming to solve it.

CO-PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	1	1	2	2	2	2
CO2	3	3	3	2	3	1	1	1	2	2	2	2
CO3	3	3	3	2	3	1	1	1	2	2	2	2

Engineering Practices Laboratory

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering)

Semester I **Hours of Instruction/week: 4P**
24BEES06 **No.of credits:2**

Course Learning Objectives:

CLO1: To study the hardware and software's and gain knowledge on MATLAB and Linux.

CLO2: To study the domestic wiring, measure the various electrical parameters, verify logic gates and to develop a circuit using electronic components.

List of Experiments:

Computer

PC Hardware and Software

1. System Assembling, Disassembling of parts/peripherals and Hardware Troubleshooting.

MS office

2. Create a document in MS Word which includes Formatting Fonts- Drop cap-Applying Text Effects - Using Character Spacing - Borders and Colors - Inserting Header and Footer - Using Date and Time option.
3. Create a PPT to present your assignment in MS Power Point which includes Basic power point utilities and tools like PPT Orientation – Slide layouts fa–Inserting Text-Word Art –Formatting Text-bullets and Numbering – Auto Shapes –Lines and Arrows.
4. Prepare students grade sheet in excel using basic functions like Sorting-Conditional Formatting –Embedded Chart- Formulas Setting- Page Layout – Spread the content of one cell over many cells-Merge Cells – split Cells – Filters – Freeze Panels – Interactive Buttons – Data protection.

MATLAB

5. Introduction to MATLAB – To define & use variables – vectors – Matrices & Its functions in MATLAB.
6. To study various arithmetic operators and mathematical functions in MATLAB and to create & use m-files.

Operating System

7. Installation of Windows Operating System and Working with basic Unix/ Linux commands.

Software Requirements: MS office, MATLAB and Red Hat Linux.

Electrical & Electronics

1. Residential house wiring using switches, fuse, indicator and lamps.
2. Staircase wiring.
3. Measurement of AC signal parameters (peak-peak, RMS value, period, frequency) using CRO.
4. (i) Identification and study of electronic components and equipments – Resistors, capacitors, inductors, colour coding and measurement.
   (ii) Identification and verification of logic gates.
5. Soldering and testing of simple electronic circuits.
6. Assembling and testing of simple electronic components on PCB.

Total Hours: 60

Course Outcomes:

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

CO1: Implement various tasks using MS Word, Power Point, and Excel.

CO2: Apply various commands in MATLAB and Linux.

CO3: Construct various types of domestic wiring, measure the various electrical parameters, verify logic gates and develop a circuit using electronic components.

CO-PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	-	1	2	2	2	3
CO2	3	3	3	2	3	1	1	1	3	2	2	2
CO3	3	2	2	1	1	1	2	-	1	1	1	1

Environmental Science

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction /week: 3T**
24BEMC01 **No. of credits: NCMC**

Course Learning Objective:

CLO 1: To study the interrelationship between living organisms and environment and to help students understand the various environment problems that we face and develop possible solutions to them.

Unit I Environment, Ecosystems and Biodiversity 11

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity- definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Field study of common plants, insects, birds.

Field study of simple ecosystems – pond, river, hill slopes, etc.

Unit II Natural Resources 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

Unit III Environmental Pollution 9

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards– solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies–disaster management: floods, earthquake, cyclone and landslides.

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

Unit IV Social Issues and the Environment 9

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment protection act– Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

Unit V Human Population and the Environment 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health –Case studies.

Total Hours: 45

References:

1. ***Raman Sivakumar, "Introduction to Environmental science and Engineering",*** McGraw Hill Education, ISBN 13: 9780070672802, 2009.
2. ***Gilbert M.Masters, 'Introduction to Environmental Engineering and Science'***, 3rd edition, Pearson Education, ISBN-13: 9780131481930, 2008.
3. ***Benny Joseph, 'Environmental Science and Engineering'***, Tata McGraw-Hill, New Delhi, ISBN-13 9789387432352**,** 2006.
4. ***R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards'***, Vol. I and II, Enviro Media.ISBN:8186421017.
5. ***Dharmendra S. Sengar, 'Environmental law***', Prentice Hall of India Pvt. Ltd., New Delhi, ISBN-13**:** 978-8120330597, 2007.
6. ***Rajagopalan, R, 'Environmental Studies-From Crisis to Cure***', Oxford University Press, ISBN**:**9780199459759, 2005 .

Course Outcomes:

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

CO1: Will be familiar with various ecosystems and biodiversity and their importance in maintaining ecological balance.

CO2: Will be able to understand the relevance and importance of natural resources in the sustenance of life on earth.

CO3: Will be able to list different types of pollutions and their impacts on air, water and soil quality and suggest suitable measures to mitigate these impacts.

CO4: Will gain knowledge on the various environmental problems related to social issues and possible solutions to such problems.

CO5: Will be able to correlate human population growth to environmental degradation

CO-PO MAPPING

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

Universal Human Values (Understanding Harmony and Human Conduct)

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of instruction/week: 2T+1Tu**
24BEHS02 **No. of Credits: 3**

Course Learning Objectives:

CLO1: To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' in all the core aspirations of all human beings.

CLO2: To facilitate the development of a Holistic perspective among students towards life and profession based on a correct understanding of Human reality and the rest of existence.

CLO3: To highlight conceivable implications of such a Holistic understanding in terms of ethical human conduct and interaction with Nature.

CLO4: To provide a much-needed orientation input in value education to the young enquiring minds.

Unit I Introduction to Value Education **9**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations

Unit II Harmony in the Human Being **9**

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

Unit III Harmony in the Family and Society **9**

Harmony in the Family–the Basic Unit of Human Interaction, 'Trust'–the Foundational Value in Relationship, ' Respect'– as the Right Evaluation, Other Feelings, Justice in Human-to Human Relationship, Understanding Harmony in the Society, Vision or the Universal Human Order.

Unit IV Harmony in the Nature/Existence **9**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

Unit V Implications of the Holistic Understanding – a Look at Professional Ethics **9**

Natural Acceptance of Human Values, Definitiveness of(Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Total Hours: 45

References:

1. ***Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria***, Excel Books, New Delhi, 2010.
2. ***JeevanVidya: EkParichaya, ANagaraj, JeevanVidyaPrakashan***, Amarkantak,1999.
3. ***Human Values, A.N. Tripathi***, New Age Intl. Publishers, New Delhi, 2004.
4. ***The Story of Stuff (***Book).
5. ***The Story of My Experiments with Truth*** - by Mohandas Karamchand Gandhi
6. ***Small is Beautiful*** - E. F Schumacher.
7. ***Slow is Beautiful*** - Cecile Andrews
8. ***Economy of Permanence*** - J C Kumarappa
9. ***Bharat Mein Angreji Raj***–PanditSunderlal
10. ***Rediscovering India*** - by Dharampal
11. ***Hind Swaraj or Indian Home Rule*** - by Mohandas K. Gandhi
12. ***India Wins Freedom*** - Maulana Abdul Kalam Azad
13. ***Vivekananda*** - Romain Rolland (English)

Course Outcomes:

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

CO1. Understand the human reality and the rest of Existence.
CO2. Comprehend towards what they have understood on human values and relationship.
CO3. Apprehend the interconnectedness, the interdependence, the harmony all around the society.
CO4. Develop the holistic perception towards nature.
CO5. Transform from personnel to Value-based Life and Profession.

CO-PO MAPPING

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

Mathematics – II (Laplace Transforms and Complex Variables)

(Common to Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction/week:3T+1Tu**
24BESM02 **No. of Credits:4**

Course Learning Objectives:
CLO1: To enhance knowledge in Laplace transforms, vector calculus and its applications.
CLO2: To understand the concepts of complex integration and contour integration.

Unit I Laplace Transform 12

Laplace transform - Definition and sufficient conditions - Transforms of functions - Properties of Laplace transforms - Transforms of derivatives and integrals – Initial value theorem - final value theorem - Transform of periodic functions

Unit II Inverse Laplace Transform 12

Inverse Laplace transform - Properties of inverse Laplace transforms - Convolution theorem - Application to solution of linear ordinary differential equations upto second order with constant coefficients.

Unit III Analytic Functions 12

Function of a complex variable – Analytic function – Necessary conditions-Cauchy – Riemann equations in cartesian coordinates - Sufficient conditions (Proof not included)-Properties of analytic function – Determination of harmonic conjugate by Milne– Thomson method – Conformal mapping – $w = z + a, az, 1/z$

Unit IV Complex Integration 12

Statement and application of Cauchy's theorem and Cauchy's integral formula – Laurent's expansion – Singularities – Classification – Residues – Cauchy's residue theorem - Contour integration - Unit circle and semi-circular contours (excluding poles on real axis).

Unit V Vector Calculus 12

Gradient - Divergence and Curl – Green's - Gauss divergence and Stoke's theorems (without proof) - Verification of the above theorems and evaluation of integrals using them.

Total Hours: 60

References:

1. ***T.Veerarajan (*2016), *Engineering Mathematics (for semester I and II),*** updated 2nd Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
2. ***P.Kandaswamy, K.Thilagavathy and K.Gunavathy (2014), Engineering Mathematics,*** 10th Revised Edition, S. Chand & Co, New Delhi.
3. ***E.Kreyszig (2014), Advanced Engineering Mathematics***, 8th Edition, John Wiley and Sons (Asia) Ltd, Singapore.
4. ***Dennis G.Zill and Michael R.Cullen (2012), Advanced Engineering Mathematics,*** 2nd Edition, CBS Publishers.

5. ***Srimanta Pal and Subhodh C Bhunia (2012),Engineering Mathematics,*** 9th Edition**,** John Wiley and Sons.
6. ***Dr.B.S.Grewal (2014), Higher Engineering Mathematics***, 43rd Edition, Khanna Publishers, New Delhi.
7. ***Jain R.K. and Iyengar S.R.K. (2007), Advanced Engineering Mathematics,*** 3rd Edition, Narosa Publications, New Delhi.

Course Outcomes:

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

CO1: Apply Laplace transform techniques to solve engineering problems.
CO2: Determine inverse Laplace transforms of various functions.
CO3: Construct analytic functions of complex variables and interpret its transformations.
CO4: Evaluate real and complex integrals using the techniques of complex integration.
CO5: Analyse vector differentiation and vector integration in real world problems.

CO-PO MAPPING

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

Applied Chemistry

(Common to Biomedical Instrumentation Engineering and Electronics and Communication Engineering)

Semester II **Hours of Instruction/week: 3T+2P**
24BESC01 **No. of credits:4**

Course Learning Objectives:

CLO1: To provide students with a background in important concepts and principles of Chemistry and use the knowledge gained to describe and solve real technological problems.

CLO2: To impart experimental skills and hands on experience in the use of analytical equipment needed for engineering applications.

Unit I Electrochemistry and Storage Devices 9

Electrochemical cells: Electrode potential, Nernst equation (problems). Reference electrodes: Calomel electrode, glass electrode and measurement of pH, EMF, electrochemical series and its significance. Energy Storage Devices Primary and Secondary Cells, Lechlanche cell, Lead Acid Battery, Nickel Cadmium Battery, Lithium Battery, Charging and Discharging reactions

Unit II Corrosion and its Control 9

Chemical and electrochemical corrosion: principle, mechanism, galvanic corrosion, differential aeration corrosion. Factors influencing corrosion.
Corrosion control: Selection of materials and proper designing, sacrificial anode and impressed current cathodic protection methods, corrosion inhibitors.

Unit III Polymers and Green Chemistry 9

Introduction: Functionality-degree of polymerization. Classification of polymers - Natural and synthetic, thermoplastic and thermosetting. Types of polymerization, mechanism of free radical polymerization, Properties of polymers: Tg, tacticity, molecular weight-weight average, number average and polydispersity index. Conducting polymers, types, mechanism of conduction and Applications. Green chemistry- Introduction and need for green chemistry, Principles of green chemistry.

Unit IV Nanochemistry 9

Nanomaterials –Types – Size dependence of properties, electrical, optical, magnetic and mechanical properties. Synthesis: sol-gel, electrode position and laser ablation. Characterization – Scanning Electron Microscope and Transmission Electron Microscope Principle and Instrumentation (block diagram). Applications of nanomaterials – medicine, agriculture and electronics.

Unit V Photochemistry and Spectroscopy 9

Photochemistry: Laws of photochemistry-Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law. Photo processes - fluorescence, phosphorescence and photo-sensitization. Spectroscopy: Electromagnetic spectrum-absorption of radiation-electronic, vibrational and rotational transitions. Estimation of concentration of a coloured solution by colorimetry, UV-Visible and NMR spectroscopy- principles, instrumentation (Block diagram only) and applications.

Total Hours: 45

List of Experiments

1. **pHmetry**
   To find out the strength of given hydrochloric acid by sodium hydroxide.
2. **Conductometry**
   a. Estimation of strength of acids in a mixture of acids.
   b. Estimation of Barium Chloride using Sodium Sulphate.
3. **Potentiometry**
   Estimation of ferrous ion in the given solution.
4. Determination of total hardness of water by EDTA method.
5. Determination of chloride content of water sample by argentometric method.
6. **Corrosion Experiment**
   Weight Loss method
7. Synthesis of a polymer
8. **Viscometry**
   Determination of molecular weight of a polymer
9. Estimation of concentration of a coloured solution using colorimeter
10. **Spectrophotometry**
    Estimation of iron content of water sample

Total Hours: 30

References:

1. ***Jain P. C. & Monika Jain (2015). Engineering Chemistry***. Dhanpat Rai Publishing Company (P) Ltd, New Delhi, ISBN 13: 9788187433170.
2. ***Vairam S., Suba Ramesh (2013) Engineering Chemistry***. Wiley India Pvt Ltd., New Delhi., ISBN 13: 9788126544752.
3. ***ShashiChawla (2013). A Text Book of Engineering Chemistry.*** Dhanpat Rai& Co Pvt. Ltd. 3rd Edition, 10thReprint.
4. ***Dara S.S.,Umare S.S (2010). Engineering Chemistry.*** **12th edition,** S.Chand & Company Pvt.Ltd, New Delhi., ISBN : 81-219-0359-9.
5. ***PalannaO.G (2017). Engineering Chemistry***.**2nd Edition**, McGraw-Hill Education (India) Pvt. Ltd.,Chennai, ISBN:9789352605774.
6. ***Kannan P., Ravikrishnan A (2014). Engineering Chemistry***. Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai.
7. ***Dr.Rakesh Kumar, Dr. Kamala Pati Tiwary (2013). A Textbook of Nano Science*** 2nd Edition, S.K.Kataria & Sons, New Delhi.

Course Outcomes:

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

CO1: Apply the principle of electrochemistry in the functioning of energy storage devices.
CO2: Identify the causes of corrosion and the possible techniques to minimise corrosion.
CO3: Familiar with the essential aspects of polymer chemistry and the importance of green chemistry
CO4: Get acquainted with the basics of nano materials, their characterisation and applications.
CO5: Acquire a basic knowledge about the spectroscopic techniques used for the analysis of materials.

CO-PO MAPPING

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

Computer Aided Engineering Graphics

(Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction/week: 2T+3P**

24BEES08 **No. of credits: 3**

Course Learning Objective:

CLO1: The objective of this course is to develop the students in graphic skill for communication of concepts and ideas in engineering field using AutoCAD software.

Unit I Introduction to Computer Aided Engineering Graphics **15**

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Geometrical Constructions.
Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves.

Unit II Projection of Points, Lines and Planes **15**

Introduction to Orthographic projections: orthographic projection of points.
Projection of straight lines located in the first quadrant only, determination of true length and true inclination.
Projections of plane surfaces like polygonal lamina and circular lamina, located in first quadrant only.

Unit III Projection of Simple Solids **15**

Projection of simple solids like prism, pyramid, and cylinder, Drawing views when the axis of the solid is inclined to one reference plane.

Unit IV Sectioning of Solids **15**

Sectioning of simple solids like prisms, pyramids, cylinder, cone and sphere. Obtaining sectional views and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

Unit V Isometric, Perspective Projection and freehand sketching **15**

Isometric projections, Isometric scale, Isometric views of simple solids, Free hand sketching techniques, sketching of orthographic views from given pictorial views of objects, including freehand dimensioning. Sketching pictorial views from given orthographic views. Perspective projections of solids.

Total Hours: 75

References:

1. ***Venugopal.K , "Engineering Graphics",*** New Age International (P) Limited, 2008.
2. ***Natarajan K.V, "Engineering drawing and graphics",*** 17th Edition, Private Publisher, Chennai, 2008.
3. ***Bhatt.N.D, "Engineering Drawing" ,*** Charotar Publishing House, 2011.

4. ***Kumar M.S, "Engineering Graphics",*** Ninth edition. D.D. Publications, Chennai, 2007.
5. ***Warren J, Luzadder and John.M.Duff , "Fundamentals of Engineering Drawing",*** Eleventh edition. Prentice Hall of India Pvt., Ltd., 2007.
6. ***Gopalakrishnan K.R, "Engineering Drawing (Vol.I& II)",*** Subhass Publications, 2007.
7. ***Bertoline and Wiebe, "Fundamentals of graphics Communication",*** Third edition. McGrawhill, 2007.
8. ***Dhananjay A.Jolhe, "Engineering Drawing with an introduction to AutoCAD",*** Tata McGraw Hill Publishing Company Limited, 2008.

Course Outcomes:

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

CO1: Use various commands in AutoCAD Software.
CO2: Draw orthographic projection of points, lines and plane surfaces.
CO3: Sketch projections of solids.
CO4: Draw projections of sections of solids.
CO5: Prepare isometric and perspective sections of simple solids.

CO-PO MAPPING

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

Programming for Problem Solving using Python

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction /week: 3T**

24BEES09 **No. of credits: 3**

Course Learning Objectives:

CLO1: To understand the basic knowledge in programming concepts and Problem solving using Python.

CLO2: To acquire knowledge on Python data structures, functions, modules and packages.

Unit I Introduction to Python Programming Language 9

Introduction to Python Language and installation- overview on python interpreters- working with python- Numeric Data Types: int- float- Boolean- complex and string and its operations- Standard Data Types: List- tuples- set and Dictionaries- Data Type conversions- commenting in python.

Unit II Variables and Operators 9

Understanding Python variables - Multiple variable declarations - Python basic statements- Python basic operators: Arithmetic operators - Assignment operators - Comparison operators- Logical operators- Identity operators - Membership operators - Bitwise operators - Precedence of operators- Expressions.

Unit III Control Flow and Loops 9

Conditional (if)- alternative (if-else)- chained conditional (if- elif -else)- Loops: For loop using ranges-string- Use of while loops in python- Loop manipulation using pass- continue and break- Regular Expression

Unit IV Functions 9

User Defined Functions- Calling Functions- passing parameters and arguments- Python Function arguments: Keyword Arguments- Default Arguments- Variable-length arguments- Anonymous Functions- Fruitful Functions (Function Returning Values)- Scope of the Variables in a Function - Global and Local Variables- Powerful Lambda functions in python- classes and objects.

Unit V I/O Error Handling, Modules and Packages 9

Introduction- Access Modes- Writing Data to a File- Reading Data from a File- Additional File Methods- Introduction to Errors and Exceptions- Handling IO Exceptions- Run Time Errors- Handling Multiple Exceptions. Modules: Importing Module - Packages - Compositions.

Total Hours: 45

References:

1. ***Paul Deitel and Harvey Deitel (2021).Python for Programmers.*** Pearson Education. First Edition.
2. ***John V Gutta- (2021).Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data.*** Third Edition. MIT Press.
3. ***Eric Matthes (2019). Python Crash Course, A Hands - on Project Based Introduction to Programming.*** Second Edition. No Starch Press.
4. ***Martin C. Brown, "The Complete reference – Python",*** Tata McGraw hill edition 2018.
5. ***Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python",*** Network Theory Ltd., 2011.

Course Outcomes:

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

CO1: Explain the basic constructs of python programming language.
CO2: Learn the various types of variables and operators in Python.
CO3: Acquire the knowledge on control statements.
CO4: Learn the concepts of functions.
CO5: Infer the file operations, exception handling, modules and packages in Python.

CO-PO MAPPING

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

Electric Circuit Analysis

(Common to Biomedical Instrumentation Engineering/ Electronics and Communication Engineering)

Semester II **Hours of Instruction/week: 3T**
24BEES10 **No. of credits: 3**

Course Learning Objectives:

CLO1: To introduce the basic concepts of DC and AC circuits and analyse the transient and steady state response.

CLO2: To introduce different methods of circuit analysis using Network theorems, duality and topology.

Unit I Basic Circuits Analysis **9**

Basic Components of Electric Circuits: Charge, Current, Voltage and Power, Voltage and Current Sources, Single – Loop Circuit, Single- Node Pair Circuit, Series and Parallel Connected Sources, Resistors in Series and Parallel, Voltage and Current Division, Mesh and Nodal Analysis for DC circuits, Supermesh and Supernode Analysis.

Unit II Network Theorem **9**

Useful Circuit Analysis Techniques: Linearity and Superposition, Thevinin's and Norton Equivalent Circuits, Maximum Power Transfer, Reciprocity Theorem, Millman's Theorem. Source transformation: Delta-Wye Conversion.

Unit III Sinusoidal Steady State Analysis **9**

Sinusoidal Steady - State Analysis: Characteristics of Sinusoids, Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, Impedance and Admittance, Nodal and Mesh Analysis (RLC circuit), Phasor Diagrams.

AC Circuit Power Analysis: Instantaneous Power, Average Power, Apparent Power and Power Factor, Complex Power.

Unit IV Transient Analysis **9**

Basic RL and RC Circuits, Source- Free RL Circuit, Source-Free RC Circuit, Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response: Parallel Resonance, Series Resonance and Quality Factor.

Unit V Coupled Circuits and Topology **9**

Magnetically Coupled Circuits, Self Inductance, Mutual Inductance, Linear Transformer. An Introduction to Network Topology: Graphs and Trees, Network Incidence Matrices, Basic cut-set and tie-set matrices, Loop and Nodal Analysis.

Total Hours: 45

References:

1. ***Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis",*** McGraw Hill education, 9th Edition, 2020.
2. ***Robert.L. Boylestead, "Introductory Circuit Analysis",*** Pearson Education India, Twelfth Edition, 2014.
3. ***Charles.K.Alexander, Mathew N.O.Sadiku," Fundamentals of Electric Circuits",*** McGraw Hill, Seventh Edition, 2020.
4. ***Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice",*** Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.

Course Outcomes:

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

CO1: Apply the basic concepts of circuit analysis such as Kirchhoff's laws, mesh current, and node voltage method for the analysis of DC and AC circuits

CO2: Analyze AC and DC circuits using suitable network theorem.

CO3: Examine steady-state response of any R, L and C circuits.

CO4: Analyse the transient response of RLC Circuits

CO5: Explain the concepts of coupled circuits and network topology.

CO-PO MAPPING

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

Programming for Problem Solving using Python Laboratory

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction /week: 2P**

24BEES13 **No. of credits: 1**

Course Learning Objective:

CLO1: To understand and gain knowledge on the basic concepts in Python Programming language.

List of Experiments:

1. Implement basic Python programs using various data types and to declare a variable in different possible ways.
2. Create a string and perform various string operations.
3. a. Create a list and perform the operations such as insert, remove, append, len, pop and clear.
   b. Create a tuple and perform the g operations such as add items, len, check for item in tuple.
4. Create a Dictionary and perform the operations such as print the dictionary items, access items, use get(), change values, use len().
5. Write a Python program to perform arithmetic, logical, assignment and comparison operators.
6. Implement a Python program using Conditional Statements.
7. Implement a Python programs using Looping Statements.
8. Implement a Python programs using Functions.
9. Write a Python program to double a given number and add two numbers using lambda().
10. Write a Python program to implement filter() to filter only even numbers from a given list.
11. Write a Python program to implement map() function to double all the items in the list.
12. Implement a real-time applications using Exception handling(divide by zero error, voter's age validity, student mark range validation).

Total Hours: 30

Software Requirements:

Python IDE.

References:

1. ***Paul Deitel and Harvey Deitel (2021).Python for Programmers.*** Pearson Education. First Edition.
2. ***John V Gutta- (2021).Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data.*** Third Edition. MIT Press.
3. ***Eric Matthes (2019). Python Crash Course, A Hands - on Project Based Introduction to Programming.*** Second Edition. No Starch Press.
4. ***Martin C. Brown, "The Complete reference – Python",*** Tata McGraw hill edition 2018.
5. ***Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python",*** Network Theory Ltd., 2011.

Course Outcomes:

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

- **CO1:** Experiment the fundamental concepts, control statements and functions in Python programming.
- **CO2:** Apply sequence data types concepts in Python programming to provide solutions to solve real world applications.
- **CO3:** Analyze the real world problems and use appropriate concepts in python to solve it.

CO-PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	1	1	2	2	2	2
CO2	3	3	3	2	3	1	1	1	2	2	2	2
CO3	3	2	3	2	3	1	1	1	2	2	2	2

Electric Circuit Analysis Laboratory

(Common to Biomedical Instrumentation Engineering/ Electronics and Communication Engineering)

Semester II **Hours of Instruction/week: 2P**
24BEES14 **No. of credits:1**

Course Learning Objective:

CLO1: To make the students verify the basic network theorems and analyze the frequency response of basic circuits.

List of Experiments:

1. Verification of electrical circuit problems using Kirchhoff's voltage and current laws.
2. Verification of electrical circuit problems using Thevinin's Theorem.
3. Verification of electrical circuit problems using Norton theorem
4. Verification of electrical circuit problems using Super Position Theorem.
5. Verification of electrical circuit problems using Maximum Power Transfer Theorem.
6. Verification of Reciprocity Theorem.
7. Verification of Millman's Theorem.
8. Transient analysis of RL and RC circuits.
9. Determine the frequency response of RLC electric circuit.
10. Design and Simulation of series resonance circuit.
11. Design and Simulation of parallel resonance circuit.
12. Study on functioning of Spectrum Analyzer.

Total Hours: 30

Course Outcomes:

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

CO1: Analyze and verify the basic network theorems

CO2: Analyze the transient response of RLC circuits.

CO3: Design and simulate the frequency response of resonance circuits.

CO-PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	1	2	1	-	-	1	1	-	1
CO2	2	2	1	1	2	1	-	-	1	1	-	1
CO3	2	2	1	1	2	1	-	-	1	1	-	1

Constitution of India

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction/week:2T**
24BEMC02 **No. of Credits: NCMC**

Course Learning Objectives:

CLO1: To know about historical background of the constitution making and its importance for building a democratic India.
CLO2: Elucidate the functioning of three wings of the government i.e., executive, legislative and judiciary.
CLO3: Expound the value of the fundamental rights and duties for becoming good citizen of India.
CLO4: Analyse the decentralization of power between central, state and local self-government.

Unit I History of Making of the Indian Constitution 6

History, Drafting Committee,(Composition & Working), Philosophy of the Indian Constitution-Preamble, Salient Features

Unit II Contours of Constitutional Rights & Duties 6

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit III Organs of Governance 6

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Unit IV Local Administration 6

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, Panchayatraj: Introduction, PRI: Zila Pachayat. Elected officials and their roles

Unit V Election Commission 6

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Total Hours: 30

References:

1. ***The Constitution of India, 1950(BareAct),*** Government Publication.
2. **M.V.Pylee, "*Introduction to the Constitution of India*",** 4th Edition, Vikas publication, 2005.
3. ***Durga Das Basu, "Introduction to the constitution of India", (***Student Edition), 19th edition, Prentice-Hall EEE, 2008.

Course Outcomes:

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

CO1: Comprehend the history of Indian Constitution and the various schedules under it.

CO2: Exercise the fundamental rights in proper sense at the same time identifies his/her responsibilities in national building.

CO3: Appreciate and discuss the basic components of Indian constitution, Constitutional rights and duties and various Organs of Governance

CO4: Analyse the Indian political system, the powers and functions of the Union, State and Local Governments in detail

CO5: Understand Electoral Process, Emergency provisions and Amendment procedure.

CO-PO MAPPING

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

Mathematics – III (Partial Differential Equations and Numerical Techniques)

(Electronics and Communication Engineering)

Semester: III **Hours of Instruction/week: 3T**

Couse Code: 24BESM07 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To acquire the knowledge on methods of solving partial differential equations

CLO2: To introduce the numerical techniques of interpolation, differentiation and integration which plays an important role in engineering and technology discipline.

UNIT - I Fourier Series **9**

Dirichlet's conditions - General Fourier series - Half Range Sine and Cosine series - Harmonic Analysis.

UNIT - II Partial Differential Equations **9**

Solution of standard types of first order equations - Lagrange's equation - Linear partial differential equation of second and higher order with constant coefficients.

UNIT - III Boundary Value Problems **9**

Classification of second order linear partial differential equations - Solutions of one – dimensional wave equation - Steady state solution of two dimensional heat equation - Fourier series solution in Cartesian coordinates.

UNIT - IV Numerical Methods for Ordinary Differential Equations **9**

Ordinary differential equations: Initial value problems - Taylor series - Picard's method - Fourth order Runge - Kutta methods - Predictor Corrector methods - Milne's and Adams Bashforth method.

UNIT - V Numerical Methods for Partial Differential Equations **9**

Finite difference approximations to partial derivatives - finite difference method for elliptic - parabolic equations - One dimensional heat flow - Bender Schmidt recurrence relation - Liebmann procedure for Laplace equation.

Total hours: **45**

References*:*

1.Kandaswamy.P., Thilagavathy. K. & Gunavathy. K. (2007), *Engineering Mathematics, III Semester*, S.Chand & Co, New Delhi, 1st Edition.

2.Veerarajan. T. (2014), *Transforms, Partial Differential Equations and Applications*, Tata McGraw – Hill Publishing Company Limited, New Delhi, 3rd Edition.

3. Kreyszig. E. (2014), *Advanced Mathematics*, John Wiley and Sons. (Asia) Pvt Ltd, Singapore, 9th Edition.

4. Grewal. B.S. (2014), *Higher Engineering Mathematics*, Khanna Publishers, New Delhi, 43rd Edition.

5. Grewal. B.S. & Grewal, J.S (2015), *Numerical Methods in Engineering and Science*,

Khanna Publishers, New Delhi, 10th Edition.
6. Kandaswamy. P., Thilagavathy. K. & Gunavathy. K. (2013), *Numerical Methods*, S.Chand & Co. Ltd, Delhi.

Course Outcomes:

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

CO1: Develop Fourier series for functions
CO2: Understand basic analytical techniques for solving partial differential equations
CO3: Analyse methods to solve boundary value problems
CO4: Acquaint the knowledge of various techniques and methods in solving ordinary differential equations
CO5: Apply various numerical techniques to solve partial differential equations

CO-PO Mapping

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

C++ and Data Structures

Semester: III **Hours of Instruction /week: 3T**

Course Code: 24BEES18 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the C++ concepts of classes, objects, abstraction, encapsulation, constructor, polymorphism, overloading and inheritance.

CLO2: To apply the concepts of stacks, queues, trees and various sorting and searching methods.

UNIT - I Principles of Object Oriented Programming 9

Introduction - Tokens – Expressions - control Structures – Functions in C++ - classes and objects - constructors and destructors - operators overloading and type conversions.

UNIT - II Advanced Object Oriented Programming 9

Inheritance - Extending classes - Pointers - Virtual functions and polymorphism – File Handling Templates - Exception handling - Manipulating strings.

UNIT - III Linear Data Structures 9

Algorithm - Analysis - Lists - Stacks and queues - Priority queues-Binary Heap-Application – Heaps – hashing - hash tables without linked lists.

UNIT - IV Nonlinear Data Structures 9

Trees - Binary trees - search tree ADT - AVL trees - Graph Algorithms - Topological sort - shortest path algorithm network flow problems-minimum spanning tree - Introduction to NP - completeness.

UNIT - V Sorting and Searching 9

Sorting – Insertion sort - Shell sort - Heap sort - Merge sort - Quick sort - Indirect sorting - Bucket sort - linear search - binary search.

Total Hours: 45

References:

1. Mark Allen Weiss. (2007). *Data Structures and Algorithm Analysis in C*. Pearson Education Asia. 3rd Edition
2. E. Balagurusamy. (2007). *Object Oriented Programming with C++*. McGraw Hill Company Ltd.
3. Bjarne Stroustrup. (2000). *The C++ Programming Language*. Addison Wesley.
4. Jean – Paul Tremblay & Paul G.Sorenson. (2002). *An Introduction to data structures with applications.* Tata McGraw Hill Edition. 2nd Edition.

Course Outcomes:

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

CO1: Interpret the concepts of basic object oriented programming like tokens, classes, objects and functions.

CO2: Infer the advanced object oriented programming concepts like abstraction, encapsulation, constructor, polymorphism, overloading and inheritance.

CO3: Explain the linear data structures like stacks, queues, linked lists and hash tables

CO4: Analyze the non linear data structures and NP – completeness.

CO5: Apply various sorting and searching techniques for solving a problem.

CO-PO MAPPING

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

Electronic Devices and Circuits

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BELC01 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: Familiarize students with basics of electronic devices, their behavior, properties for designing biasing circuits.

CLO2: To design and analyze BJT, FET small signal amplifiers, power amplifiers, tuned amplifiers, feedback amplifiers, oscillator circuits, multivibrator circuits and power supplies.

UNIT - I Semiconductor Devices 9

PN junction diode, Zener diode, BJT, FET, UJT - structure, operation and V-I characteristics, Applications: Rectifiers - Half Wave and Full Wave Rectifier, Zener as regulator.

UNIT - II Small Signal Amplifiers 9

Load line, operating point, biasing methods for BJT and FET**,** BJT small signal model -Analysis of CE, CB, CC amplifiers, FET small signal model- Analysis of CS, CG and Source follower, Multistage Amplifiers, Gain and frequency response.

UNIT - III Power Amplifiers and Tuned Amplifiers 9

Power amplifiers: definitions and amplifier types -Q point placement - Class A amplifier - Class B, Class AB push pull amplifiers –Amplifier distortion- Heat sink. Tuned amplifiers: Need for tuned circuits - Single Tuned Amplifiers– Double tuned - synchronously tuned Amplifiers.

UNIT - IV Feedback Amplifiers and Oscillators 9

Review of amplifier, feedback amplifier: Concept of feedback - effects of negative feedback - feedback connection types - Voltage series, current series, voltage shunt, current shunt. Concept of stability. Oscillator circuits: Oscillator principles- LC oscillators (Hartley, Colpitt, Clapp), RC oscillators (phase shift, Wien bridge), crystal oscillator.

UNIT - V Multivibrator Circuits and Power Supplies 9

Multivibrators- Astable multivibrator, Bistable multivibrator, Monostable Multivibrator, Schmitt Trigger, Electronically regulated DC power supplies (Rectifiers, Filters, Voltage Regulators) Switched mode power supply.

Total Hours: **45**

References:

1 Sedra Smith. (2017). *Microelectronic Circuits*. Oxford University Press. 7th Edition.

2 R. Boylestad and L. Nashelsky. (2017). *Electronic Devices & Circuit Theory.* PHI Publication. 11th Edition.

3 Millman & Halkias. (2015).*Electronic Devices and Circuits*. McGraw Hill. 4th Edition.

4 Salivahanan. S. &Suresh Kumar. N. (2016). *Electronic Devices and circuits*. McGraw Hill. 4th Edition.

5 A.K. Maini. (2022). *Analog Electronics.* Khanna Book Publishing.1st Edition.

Course Outcomes:

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

CO1: Understand the structure and working operation of basic electronic devices.

CO2: Design and analyze amplifiers.

CO3: Compute the frequency response of tuned amplifiers and efficiency of the power amplifiers.

CO4: Design and analyze feedback amplifiers and oscillator principles.

CO5: Discuss the operation and characteristics of multivibrator circuits and design a power supply unit.

CO - PO MAPPING

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

Signals and Systems

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BELC02 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the classification of signals and systems and introduce the transforms for analyzing continuous time and discrete time signals.

CLO2: To analyze continuous time and discrete time Linear Time Invariant (LTI) system using Fourier, Laplace transform and Z transform.

UNIT - I Classification of Signals and Systems **9**

Standard signals - Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids, Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems - CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable

UNIT - II Analysis of Continuous Time Signals **9**

Fourier series for periodic signals, Fourier Transform – properties, Laplace Transforms and Properties.

UNIT - III Linear Time Invariant Continuous Time Systems **9**

Impulse response, Convolution integrals, Differential Equation, Fourier and Laplace transforms in Analysis of CT systems.

UNIT - IV Analysis of Discrete Time Signals **9**

Baseband signal Sampling, Fourier Transform of Discrete Time signals (DTFT) – Properties of DTFT, Z Transform & Properties.

UNIT - V Linear Time Invariant Discrete Time Systems **9**

Impulse response, Difference Equation, Convolution Sum, Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems.

Total Hours: **45**

References:

1 Allan V. Oppenheim, Wilsky. S & Nawab. S.H. (2022). *Signals and Systems.* Pearson. 2nd Edition.

2 Edward W Kamen & Bonnie's Heck. (2014). *Fundamentals of Signals and Systems.* Pearson Education.

3 Simon Haykins & Barry Van Veen. (2021). *Signals and Systems*. John Wiley & Sons. 2nd Edition.

4 Rodger E. Ziemer, William H. Tranter & Ronald Fannin. D. (2014). *Signals & Systems*. Pearson Education.4th Edition.

5 Lathi. B.P. (2017). *Principles of Linear Systems and Signals*. Oxford. 3rd Edition.

Course Outcomes:

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

CO1: Determine the characteristics of signals and systems.

CO2: Analyze the continuous time signals using the Fourier series, Fourier transform and Laplace transform.

CO3: Apply Laplace and Fourier transform to examine continuous time LTI systems.

CO4: Analyze the discrete time signals using Fourier and Z transforms.

CO5: Apply DTFT and Z transforms to examine discrete-time LTI systems.

CO - PO MAPPING

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

Digital System Design

Semester: III **Hours of Instruction/Week: 3T**

Corse code: 24BELC03 **No.of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.

CLO2: Design Combinational, sequential digital circuits and be familiar with logic families, programmable logic devices and VLSI design flow.

UNIT - I Boolean Algebra and Simplification **9**

Review of Boolean algebra and DeMorgan's theorem, SOP & POS forms, canonical forms, minimization of logical expressions using Karnaugh map and tabulation method, Boolean expression implementation using universal gates, alphanumeric codes, error detecting and correcting codes.

UNIT - II Combinational Logic Design **8**

Adders, subtractors, multiplier and divider, encoder, priority encoder, decoder, multiplexer, demultiplexer, comparator, parity generator/checker, code converters, multiplexers and decoders as building blocks.

UNIT - III Sequential Logic Design **12**

SR, JK, T and D Flip-Flops (FF), master-slave FF, edge triggered FF, ripple and synchronous counters, shift registers, finite state machines, design of synchronous FSM, Algorithmic State Machines (ASM) charts, designing synchronous circuits - pulse train generator, pseudo random binary sequence generator, clock generation.

UNIT - IV Logic Families and Programmable Logic Devices **8**

TTL, ECL and CMOS logic families - parameters and their interfacing, memory elements, logic implementation using programmable logic devices, introduction to FPGA.

UNIT - V VLSI Design flow **8**

Design entry - schematic, FSM and HDL, Verilog HDL -Hierarchical Modeling Concepts, Basic Concepts, Modules and Ports, dataflow, behavioral and gate level modeling, synthesis and simulation, Verilog HDL codes for simple combinational and sequential circuits.

Total Hours: **45**

References:

1 M. Morris Mano.(2018).*Digital Design.* Prentice Hall of India Pvt.Ltd. 6th Edition.

2 R.P. Jain.(2018). *Modern digital Electronics.* Tata McGraw Hill. 4th edition.

3 Samir Palnitkar.(2003),*Verilog HDL: A Guide to Digital Design and Synthesis.* Prentice Hall PTR. 2nd edition.

4 W.H. Gothmann.(2006). *Digital Electronics- An introduction to theory and practice.* PHI, 2nd edition.

5 John Michael Williams.(2014).*Digital VLSI Design with Verilog.* Springer International Publishing Switzerland. 2nd edition.

Course Outcomes:

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

CO1: Use specific reduction methods to simplify and implement digital logic circuits.

CO2: Design and implement different combinational circuits.

CO3: Design and implementation of various sequential circuits.

CO4: Analyze the properties of logic families and discuss the performance and efficiency of memory.

CO5: Write performs for combinational and sequential circuits in Verilog HDL.

CO - PO MAPPING

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

Networks and Transmission Lines

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BELC04 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To design networks and filters by using analysis and synthesis methods.
CLO2: To apply impedance matching networks in communication systems.

UNIT - I Network Configuration 9

Functional classifications of networks - T section- pi section. Filters: Filter Fundamentals-Design of filters- Constant K - Low Pass, High Pass, Band Pass, Band Elimination- m- derived sections - low pass, high pass and composite filters.

UNIT - II Network Synthesis 9

Elements of realizability, Hurwitz polynomials, positive real functions, testing for positive realness of the function, synthesis of RL, RC and LC Driving point Immittance functions using simple canonical Networks-Foster and Cauer forms.

UNIT - III Transmission Line Theory 9

General theory of Transmission lines - the transmission line - general solution - The infinite line - Wavelength, velocity of propagation - Waveform distortion - the distortion-less line - Line not terminated in Z_0 - Reflection coefficient - calculation of current, voltage, power delivered and efficiency of transmission - Input and transfer impedance - Open and short circuited lines - reflection factor and reflection loss.

UNIT - IV Transmission Line at Radio Frequency 9

Transmission line equations at radio frequencies - Line of Zero dissipation - Voltage and current on the dissipation-less line, Standing Waves, Nodes, Standing Wave Ratio - Input impedance of the dissipation-less line - Open and Short-circuited lines.

UNIT - V Impedance Matching and Measurements 9

Impedance matching: Quarter wave transformer - Impedance matching by stubs - Single stub and double stub matching - Smith chart - Solutions of problems using Smith chart - Single and double stub matching using Smith chart.

Total Hours: **45**

References:

1 John D Ryder. (2015). *Networks, lines and fields*. Prentice Hall India. 2nd Edition.

2 Umesh Sinha. (2010). *Transmission Lines and Networks*. Satyaprakashan Publishers. 6th Edition.

3 Sudhakar. A. & Shyam Mohan. S.P. (2017). *Network Analysis and Synthesis*. Tata McGraw Hill.

4 Chakrabarthy A. (2018). *Circuit Theory Analysis & Synthesis*. Dhanpath Rai & Co

5 G.S.N.Raju. (2006). *Electromagnetic Field Theory and Transmission Lines*. Pearson Education.

Course Outcomes:

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

CO1: Analyze and design diverse network configurations and filters.

CO2: Synthesize and design RL, RC and LC networks by using driving point immittance functions

CO3: Demonstrate the transmission of signals through transmission lines and interpret its parameters.

CO4: Analyze and apply dissipation-less lines, open and short circuit lines in networks.

CO5: Apply impedance matching concepts and solve it by using smith chart.

CO - PO MAPPING

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

Electronic Devices and Circuits Laboratory

Semester: III **Hours of Instruction/week: 3P**

Course Code: 24BELC05 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To learn the operation and characteristics of electronic devices.
CLO2: To understand the operation of amplifiers, oscillators and multivibrators.

List of Experiments:

1. Characteristics of PN junction diode
2. Full wave rectifier with filters
3. Design of Zener diode regulator
4. Common Base input-output characteristics
5. FET (Common Source) drain and transfer characteristics
6. Frequency response of CE and CS amplifiers
7. Design of Class B power amplifier
8. Frequency response of single tuned amplifiers
9. Frequency response of current series amplifiers
10. Construct Hartley oscillator using transistor and find the frequency of oscillation
11. Construct RC phase shift oscillator using transistor and find the frequency of oscillation
12. Design and test the performance of astable multivibrator.

Total Hours: **45**

Course Outcomes:

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

CO1: Explain the characteristics of electronic devices.

CO2: Design and test the BJT, FET small signal amplifiers and power amplifiers.

CO3: Design and analyse tuned amplifiers, feedback amplifiers, oscillators and Multivibrators.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	1	-	1	2	1	1	1
CO2	2	2	2	1	2	1	-	1	2	1	1	1
CO3	2	2	2	1	2	1	-	1	2	1	1	1

Digital System Design Laboratory

Semester: III **Hours of Instruction/Week: 3T**

Corse code: 24BELC06 **No. of credits: 1**

Course Learning Objectives (CEOs):

CLO1: Prepare students to design and implement combinational and sequential logic circuits using gates by using hardware and Verilog HDL software.

CLO2: Students able to understand the concept of logic gates for digital circuit designing by using Verilog HDL software

List of Experiments:

1. Design and verification of combinational logic
    a) Boolean expression implementation
    b) Adder
    c) Subtractor
    d) Multiplexer
    e) Demultiplexer
    f) Encoder
    g) Decoder
    h) Code converters
    i) Parity generator
    j) Comparator
2. Testing of flip - flops using gates and ICs.
3. Design and verification of sequential logic circuits
    a) counters
    b) shift registers
4. Design and testing of sequence detector.
5. Implementation of seven segment display system (using counter and decoder).
6. Code and simulate simple combinational circuits using Verilog HDL. (Arithmetic units, Encoder, Flip Flops and Parity Generators).

Total Hours: 45

Course Outcomes:

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

CO1 : Design and implement combinational and synchronous sequential circuits using universal gates.

CO2 : Design and demonstrate simple digital systems using various chips.

CO3 : Demonstrate the use of Verilog HDL for simulation of different digital logic circuits.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	1	3	-	-	1	2	1	1
CO2	2	1	2	2	1	3	-	-	1	2	1	1
CO3	3	1	2	2	1	3	-	-	1	2	3	3

School of Engineering

Consumer Affairs

(Non – Credit Mandatory Course)

(Applicable for the B.E students admitted from the academic year 2024-2025 & onwards)

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BEMC03

Course Learning Objectives (CLOs):

CLO1: To familiarize the students with their rights and responsibilities as a consumer.
CLO2: To expound the social framework of consumer rights and legal framework of protecting consumer rights.

UNIT - I Conceptual Framework 9

Consumer and Markets: Concept of Consumer, Nature of markets: Liberalization and Globalization of markets with special reference to Indian Consumer Markets, E-Commerce with reference to Indian Market. Concept of Price in Retail and Wholesale, Maximum Retail Price (MRP), Fair Price, GST, labelling and packaging along with relevant laws, Legal Metrology.

Experiencing and Voicing Dissatisfaction: Consumer buying process, Consumer Satisfaction/dissatisfaction-Grievances-complaint, Consumer Complaining Behaviour: Alternatives available to Dissatisfied Consumers; Complaint Handling Process: ISO 10000 suite

UNIT - II The Consumer Protection Law in India 9

Objectives and Basic Concepts: Consumer rights and UN Guidelines on consumer protection, Consumer goods, defect in goods, spurious goods and services, service, deficiency in service, unfair trade practice, restrictive trade practice.

Organizational set-up under the Consumer Protection Act: Advisory Bodies: Consumer Protection Councils at the Central, State and District Levels; Adjudicatory Bodies: District Forums, State Commissions, National Commission: Their Composition, Powers, and Jurisdiction (Pecuniary and Territorial), Role of Supreme Court under the CPA with important case law.

UNIT - III Grievance Re-dressal Mechanism under the Indian Consumer Protection Law 9

Who can file a complaint? Grounds of filing a complaint; Limitation period; Procedure for filing and hearing of a complaint; Disposal of cases, Relief/Remedy available; Temporary Injunction, Enforcement of order, Appeal, frivolous and vexatious complaints; Offences and penalties.

Leading Cases decided under Consumer Protection law by Supreme Court/National Commission: Medical Negligence; Banking; Insurance; Housing & Real Estate; Electricity and Telecom Services; Education; Defective Products; Unfair Trade Practices.

UNIT - IV Role of Industry Regulators in Consumer Protection 9

I. Banking: RBI and Banking Ombudsman
II. Insurance: IRDA and Insurance Ombudsman
III. Telecommunication: TRAI
IV. Food Products: FSSAI
V. Electricity Supply: Electricity Regulatory Commission
VI. Real Estate Regulatory Authority

UNIT - V Contemporary Issues in Consumer Affairs 9

Consumer Movement in India: Evolution of Consumer Movement in India. Formation of consumer organizations and their role in consumer protection. Misleading Advertisements and sustainable consumption. National Consumer Helpline, Comparative Product testing, Sustainable consumption and energy ratings.

Quality and Standardization: Voluntary and Mandatory standards; Role of BIS, Indian Standards Mark (1S1), Ag- mark, Hallmarking. Licensing and Surveillance; Role of International Standards: 1SO an Overview

Note: Unit II and III refers to the Consumer Protection Act, 1986. Any change in law would be added appropriately after the new law is notified.

Total Hours: **45**

References:

1. Khanna, Sri Ram, Savita pHanspal, Sheetal Kapoor, and H.K. Awasthi. (2007). *Consumer Affairs*. University Press.
2. Choudharv, Ram Naresh Prasad (2005). *Consumer Protection Law Provisions and Procedure,* Deep and Deep Publications Pvt. Ltd.
3. G. Ganesan and M. Sumathy. (2012). *Globalisation and Consumerism*: *Issues and Challenges,* Regal Publications.
4. Suresh Misra and Sapna Chadah (2012). Consumer Protection in India: Issues and concerns, IIPA, New Delhi
5. Rajyalaxrni Rao (2012), *Consumer is King,* Universal Law Publishing Company
6. Empowering Consumers e-book.
7. The Consumer Protection Act, 1986 and its later versions.

Articles:

1. Misra Suresh, (Aug 2017) "Is the Indian Consumer Protected? One India One People.
2. Raman Mittal, SonkarSumit and Parineet Kaur (2016) Regulating Unfair TradePractices: An Analysis of the Past and Present Indian Legislative Models, Journal of Consumer Policy.
3. Chakravarthy, S. (2014). MRTP Act metamorphoses into Competition Act. CUTS Institute for Regulation and Competition position paper. Available online at www.cuts-international.org/doc01.doc
4. Kapoor Sheetal (2013) "Banking and the Consumer" Akademos (ISSN 2231-0584)
5. Bhatt K. N., Misra Suresh and ChadahSapna (2010). Consumer, Consumerism and Consumer Protection, Abhijeet Publications.
6. KapoorSheetal (2010) "Advertising-An Essential Part of Consumer's Life-Its Legaland Ethical Aspects", Consumer Protection and Trade Practices Journal, October 2010.

7. Verma, D.P.S. (2002). Regulating Misleading Advertisements, Legal Provisions and Institutional Framework.Vikalpa. Vol. 26:No. 2. pp. 51-57.

Periodicals:

1. *Consumer Protection Judgments (CPJ*) (Relevant cases reported in various issues).
2. *Recent issues of magazines: International Journal on consumer law and practice*, National Law School of India University, Bengaluru.
3. *Consumer Voice.* Published by VOICE Society, New Delhi.

Websites:

www.ncdrc.nic.in
www.consumeraffairs.nic.in
www.iso.org.
www.bis.org.in
www.consumereducation.in
www.consumervoice.in
www.fssai.gov.in
www.cercindia.org

Course Outcomes:

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

CO1: Understand the concepts of consumer, markets, relevant laws and grievances
CO2: Familiarize with the consumer protection laws, objectives and concepts
CO3: Awareness of Grievance Redressal Mechanism under the Indian Consumer Protection Law and Case studies.
CO4: Comprehend the business firms' interface with consumers and the consumer related regulatory and business environment.
CO5: Awareness of contemporary issues in consumer affairs and knowledge of quality and standards.

CO - PO MAPPING

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

Department of Electronics and Communication Engineering

Embedded System for Beginners

(Value Added Course)

Semester: III

Course Code: 24BELVO1

Pre–Requisite: Microcontroller and Microprocessor

Course Learning Objectives (CLOs):

CLO1: To understand the concepts of Arduino and Rasperry Pi for real time applications.
CLO2: To learn about interfacing concepts with Arduino and Rasperry Pi.

UNIT - I Fundamentals of Electronics **8**

Overview of basic electronic components - Resistors, Capacitors, Diodes, Transistors, Voltage regulator

UNIT - II Introduction to Embedded Systems **8**

Common features of Microprocessor and Microcontrollers, Types of Microcontrollers, Introduction to embedded systems.

UNIT - III Introduction to Arduino and Rasperry Pi **8**

Arduino family- Exploring Arduino board and the IDE, Pin Configuration-Pins configured for input/output functions, Delay functions, Arduino interrupts. Rasperry Pi architecture and Pin Configuration

UNIT - IV Interfacing Devices with Arduino and Rasperry Pi **8**

Interfacing: LED's, Switches, Buzzer, IR sensors Temperature sensor, Humidity sensor, IR sensor and Ultrasonic sensor and seven segment display.

UNIT - V IoT Applications **8**

Building IoT Applications using Arduino and Raspberry Pi.

Total Hours: **40**

References:

1 Yu-Cheng Liu, Glenn A. Gibson.(2007).*Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design*, Prentice Hall of India, 2nd Edition.

2 Ajay V Deshmukh.(2010).*Microcontrollers (Theory and Applications).*Tata McGraw Hill.

3 Arumugam, M., & Prem kumaran, N.(2006).*Electric circuit theory*, Khanna Publisher, 4th Edition.

4 Arshdeep Bahga., & Vijay Madisetti.(2015). *Internet of Things – A hands-on approach*, Universities Press,

5 Simon Honk.(2015).*Programming with the Raspberry pi.* 2nd Edition.

6 Jermey Blum.(2013).*Exploring Arduino, tools and technology for engineering* Wizardry.Wiley.

Course Outcomes:

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

CO1: Understand the basic electronics component and its function.

CO2: Analyse the various features on Microprocessor and Microcontrollers and its types.

CO3: Illustrate the arduino family and its interrupt.

CO4: Discuss on sensor interfacing with ardunio and Rasperry Pi

CO5: Explain about IoT applications.

CO - PO MAPPING

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

Mathematics – IV (Probability and Stochastic Processes)

(Electronics and Communication Engineering)

Semester: IV **Hours of Instruction/ week: 3T+1Tu**

Course Code: 24BESM10 **No. of credits: 4**

Course Objectives (CLOs):

CLO1: To have a fundamental knowledge of the basic probability concepts and apply the same in system design, reliability and propagation studies.

CLO2: To understand the necessary basic concepts in random processes for modelling linear systems.

UNIT - I Probability and Random Variables 12

Axioms of probability - Conditional probability - Total probability - Baye's theorem - Random variable - Probability mass function - Probability density function –Properties–Moments - Moment generating function and properties.

UNIT - II Standard Distributions 12

Binomial - Poisson - Geometric - Uniform - Exponential and Normal distributions and their properties.

UNIT - III Two Dimensional Random Variables 12

Joint distributions - Marginal and conditional distributions - Correlation and regression - Transformation of random variables - Characteristic function of a random variable - Chebychev's inequality - Central limit theorem.

UNIT - IV Random Processes 12

Definition - Basic concepts and examples - Stationary and second order process - Weakly stationary process - Covariance function and its properties - Ergodicity - Transmission of random process through LTI - Power spectral density function.

UNIT - V Linear Systems with Random Inputs 12

Linear operations - Gaussian process - Poisson process - Low pass and band pass noise representations.

Total hours: 60

References:

1. Veerarajan. T. (2010), *Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks*, Tata McGraw –Hill, 3rd Edition.
2. Kandaswamy.P., Thilagavathy. K. & Gunavathy. K. (2006), *Probability, Random Variables and Random Processes*, S.Chand & Co.Ltd, Delhi.
3. Ross. S.M (2004), *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier, 3rd Edition.
4. Trivedi. K.S. (2016), *Probability and Statistics with Reliability, Queueing and Computer Science Applications*, Prentice Hall of India, New Delhi, 2nd Edition.
5. Papoulis. A. & Unnikrishnapillai. S. *Probability, Random Variables and Stochastic Processes*,(2010), McGraw Hill Education India, New Delhi, 4th Edition.
6. Yates. R.D. & Goodman. D. J. (2012), *Probability and Stochastic Processes*, Wiley India Pvt. Ltd., Bangalore, 2nd Edition.
7. Miller and Freund's (2011), *Probability and Statistics for Engineers*, Prentice Hall India Learning Private Limited, 8th Edition.

Course Outcomes:

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

CO1: Understand basic probability concepts and construct simple probability measures for discrete and continuous random variables

CO2: Discuss various distribution functions

CO3: Acquire skills in handling situations involving more than one random variable

CO4: Apply the concepts of Random Processes

CO5: Analyse the response of random inputs to linear time invariant systems

CO-PO Mapping

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

Linear Integrated Circuits

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BELC07 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the fundamental building blocks of operational amplifiers.
CLO2: To learn the linear and non-linear applications of operational amplifiers and study about the special function ICs.

UNIT - I IC Fabrication and Circuit Configuration for Linear ICS 9

Advantages of ICs over discrete components, Manufacturing process of monolithic ICs, Current mirrors and current sources, current sources as active loads, Voltage sources and voltagereferences, BJT Differential amplifiers with active loads, Monolithic IC operational amplifiers, specifications, DC and AC Performance Characteristics, slew rate and methods of improving slew rate, open and closed configurations.

UNIT - II Applications of Operational Amplifiers 9

Inverting and Non- Inverting Amplifiers, Voltage follower, Adder, Subtractor, Differentiator, Integrator, Voltage to current converter, Instrumentation amplifiers, Sine wave Oscillator, Low pass and band pass filters, Comparator and Schmitt trigger, Precision rectifier, Log and Antilog amplifiers.

UNIT - III Analog Multiplier and PLL 9

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell and variable transconductance multipliers, Closed loop analysis of PLL, Voltage controlled Oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing.

UNIT - IV Analog to Digital and Digital to Analog Converters 9

Analog and Digital Data Conversions, D/A converter - weighted resistor type, R-2R Ladder type and Inverted R - 2R Ladder types, switches for D/A converters, high speed sample-and-hold circuits, A/D Converters - Flash type, Successive Approximation type, Single Slope, Dual slope, Successive approximation, Delta Sigma Modulation and Voltage to Time converter.

UNIT - V Special Function ICs 9

Astable and Monostable Multivibrators using 555 Timer, Voltage regulators, linear and switched mode types, Switched capacitor filter, Frequency to Voltage Converters, Tuned amplifiers, Power amplifiers and Isolation Amplifiers, Video amplifiers, Fiber Optic ICs and Optocouplers.

Total Hours: **45**

References:

1 D.Roy Choudhry, Shail Jain. (2018). *Linear Integrated Circuits*. New Age International Pvt. Ltd. 5th Edition.

2 Sergio Franco. (2016). *Design with Operational Amplifiers and Analog Integrated Circuits*. Tata Mc Graw-Hill. 4th Edition.

3 Gray and Meyer. (2024). *Analysis and Design of Analog integrated Circuits*, Wiley International. 6th Edition.

4 Ramakant A. Gayakwad. (2015). *OP-AMP and Linear ICs*. Prentice Hall / Pearson Education. 4th Edition.

5 Sedra Smith. (2017). *Microelectronic Circuits*. Oxford University Press. 7th Edition.

Course Outcomes:

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

CO1: Describe the building blocks and AC/DC performance characteristics of an op-amp.

CO2: Design linear and non-linear circuits using op-amp.

CO3: Describe analog multiplier, Phase Locked Loop and its applications.

CO4: Construct various types of Analog to Digital and Digital to Analog Converters using op-amp.

CO5: Illustrate the function of waveform generators and special functions ICs such as Voltage regulators, Timers and Amplifier ICs.

CO - PO MAPPING

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

Electromagnetic Fields

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BELC08 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To analyze the static electric and magnetic fields using field equations
CLO2: To evaluate the wave propagation in a medium for communication applications.

UNIT - I Vector Analysis and Electro-statistics 9

Vector field - Co-ordinate systems: Rectangular, Cylindrical and Spherical Co-ordinate systems. Electro-statistics: Coulomb's Law - Electric field intensity – Electric Flux Density, Gauss's Law, Definition of potential and potential difference - Potential gradient - Current and current density - Continuity of current - Point form of Ohm's Law.

UNIT - II Steady Magnetic Field 9

Biot-Savart's law - Ampere's circuital law - Curl - Stoke's theorem - Magnetic flux and magnetic flux density – The Scalar and Vector Magnetic Potential, Derivation of the Steady-Magnetic-Field Laws.

UNIT - III Time Varying Field and Maxwell's Equations 9

Faraday's law - Displacement current – Divergence and Maxwell's First Equation, The Vector Operator ∇ and the Divergence Theorem, Maxwell's equations in point form - Maxwell's equation in integral form.

UNIT - IV Uniform Plane Waves, Reflection and Refraction 9

Wave Propagation in Free Space, Wave Propagation in Dielectrics, Poynting's Theorem and Wave Power, Propagation in Good Conductors: Skin Effect, Wave Polarization, Reflection of Uniform Plane Waves at Normal Incidence, Standing Wave Ratio, Wave Reflection from Multiple Interfaces. Plane waves in lossy and lossless medium.

UNIT - V Guided Waves and Waveguides 9

Transverse Electric waves, Transverse Magnetic waves, TEM waves, Attenuation in parallel plate waveguides - Rectangular waveguides: TM and TE modes.

Total Hours: **45**

References:

1 William H. Hayt, Jr., John A. Buck. (2020). *Engineering Electromagnetics*. McGraw Hall. 8th Edition.

2 Jordan.F.C. & R.G.Balmain. (2015). *Electromagnetic Waves and Radiating Systems*. Prentice Hall of India. 2nd Edition.

3 N.N.Rao (2006). *Elements of Engineering Electro Magnetic*s. Prentice Hall of India. 6th Edition.

4 Ramos J.R. Whinnery & T.Van Quzer. (2007). Fields *and Waves in Communication Electronics*. John Wiley and sons. 3rd Edition.

5 Plosney.R & R.E.Collin. (1987). *Principles and Applications of Electro Magnetic Fields*. Tata McGraw Hill.

6 U.A.Bakshi, A.V.Bakshi. (2017). *Electromagnetic Fields*. Technical publications.

7 William H. Hayt, Jr., John A. Buck. (2020). *Engineering Electromagnetics*. McGraw Hall. 8th Edition.

Course Outcomes:

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

CO1: Apply various vector coordinate systems to analyze the static electric fields.

CO2: Apply and analyze the steady magnetic fields.

CO3: Analyze the wave propagation by using Maxwell's equations.

CO4: Examine the behaviour of electromagnetic waves in free space and various mediums.

CO5: Explain various modes of electromagnetic waves in free space and guided medium.

CO - PO MAPPING

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

Microprocessors and Microcontrollers

Semester: IV **Hours of Instruction/week: 3T+2P**

Course Code: 24BELC09 **No. of credits: 4**

Course Learning Objectives (CLOs):

CLO1: To understand the Architecture of 8086 microprocessor and also design aspects of I/O and Memory Interfacing circuits.

CLO2: To study the Architecture of 8051 microcontroller, timer and ARM interfacing design.

UNIT - I 8086 Microprocessor **9**

Architecture, signals, minimum and maximum mode registers, addressing modes, memory segmentation, system bus structure and timing, exception handling, Assembly language programming.

UNIT - II 8086 System Bus Structure **9**

8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT - III I/O Interfacing **9**

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller

UNIT - IV 8051 Microcontroller **9**

Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Assembly language programming.

UNIT - V 8051 Timers and ARM introduction **9**

Programming 8051 Timers - Serial Port Programming, Introduction to RISC processor, ARM microcontrollers interface designs.

Total Hours: **45**

List of Experiments

Experiments using 8086 and MASM

1. Basic arithmetic and Logical operations.
2. Move a data block without overlap.
3. Code conversion, decimal arithmetic and Matrix operations.
4. Floating point operations, string manipulations, sorting and searching.

Peripherals and Interfacing Experiments

5. Traffic light controller.
6. Stepper motor control.
7. Digital Clock.
8. Key board and Display.
9. A/D and D/A interface and Waveform Generation.

Experiments using 8051

10. Basic arithmetic and Logical operations.
11. Square and Cube program, Find 2's complement of a number.
12. 12.Unpacked BCD to ASCII.

Total Hours:**30**

References:

1 A.Nagoor kani.(2021). *Microprocessor and Microcontroller*.CBS Publishers.3rd Edition.

2 SarmadNaimi., Muhammad Ali Mazidi., & SepehrNaim.(2020).*The STM32F103 Arm Microcontroller & Embedded Systems: Using Assembly & C*.Micro Digital Ed publishing.

3 Shujen Chen., Muhammad Ali Mazidi., & EshraghGhaemi.(2018).*STM32 Arm Programming for Embedded Systems: Using C Language with STM32 Nucleo.* Micro Digital Ed.

4 Ajay V Deshmukh.(2010).*Microcontrollers(Theory and Applications)*.TataMc GrawHill.

5 Mohamed Ali Mazidi., Janice Gillispie Mazidi., & Rolin Mc Kinlay.(2011).*The 8051 Microcontroller and Embedded Systems: Using Assembly and C*. Pearson education. 2ndEdition.

Course Outcomes:

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

CO1: Understand and execute programs based on 8086 microprocessor.

CO2: Analyze the concept of system bus structure.

CO3: Design and interface I/O circuits.

CO4: Design and implement 8051 microcontroller based systems.

CO5: Discuss on microcontroller timers and also basics of ARM Interfacing design.

CO - PO MAPPING

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

Computer Networks and Security

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BELC10 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: Discuss application layer services and understand UDP and TCP protocols.
CLO2: Explain routers, IP and Routing Algorithms in network layer.
CLO3: Illustrate concepts of Multimedia Networking, Security and Network Management.

UNIT - I Application Layer **8**

DNS – SMTP - FDP - HTTP – WWW – Security - Cryptography.

UNIT - II Transport Layer **9**

Duties of transport layer - Multiplexing - De-multiplexing - User Datagram Protocol (UDP) - Transmission Control Protocol (TCP)- Congestion Control - Quality of services (QOS) – Integrated Services.

UNIT - III Network Layer **8**

Internetworks - Packet Switching and Datagram approach - IP addressing methods - Sub netting – Routing - Distance Vector Routing - Link State Routing.

UNIT - IV Network Security **10**

Overview of Network Security: Elements of Network Security, Classification of Network Attacks, Security Methods, Symmetric-Key Cryptography: Data Encryption Standard (DES), Advanced Encryption Standard (AES), Public-Key Cryptography: RSA Algorithm, Diffie-Hellman Key-Exchange Protocol, Authentication: Hash Function, Secure Hash Algorithm (SHA), Digital Signatures, Firewalls and Packet Filtering, Packet Filtering, Proxy Server.

UNIT - V Multimedia Networking **10**

Properties of video, properties of Audio, Types of multimedia Network Applications, streaming stored video: UDP Streaming, HTTP Streaming, Adaptive streaming and DASH, content distribution Networks, Voice-over-IP: Limitations of the Best-Effort IP Service, Removing Jitter at the Receiver for Audio, Recovering from Packet Loss Protocols for Real-Time Conversational Applications, RTP, SIP.

Total Hours: **45**

References:

1 Behrouz A. Foruzan. (2017). *Data communication and Networking*. Tata McGraw Hill.

2 William Stallings. (2017). *Data and computer Communication*. Pearson Education. 6th Edition.

3 James F. Kurouse & W. Rouse. (2017). *Computer Networking: A Top down Approach Featuring.* Pearson Education.

4 Andrew S. Tannenbaum. (2010). *Computer Networks.* Prentice Hall of India. 5th Edition.

5 Nader F Mir. (2014). *Computer and Communication Networks*. Pearson. 2nd Edition.

Course Outcomes:

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

CO1: Explain the principles behind application layer protocols.

CO2: Recognize transport layer services and understand UDP and TCP protocols.

CO3: Classify routers, IP and routing algorithms in network layer.

CO4: Develop practical skills in configuring and managing security devices to protect network infrastructure and data.

CO5: Describe Multimedia Networking and Network Management.

CO - PO MAPPING

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

Analog and Digital Communication

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BELC11 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the importance of various analog modulation techniques and effect of various noise sources on modulated signal.

CLO2: Use various methods to reduce, detect and correct errors in communication systems and learn about digital modulation schemes.

UNIT - I Analog Signal Transmission and Reception 9

Introduction to Modulation – Amplitude Modulation Systems - DSB, SSB and VSB modulations, Implementation of AM modulators and Demodulators, Signal multiplexing (TDM, FDM and Quadrature carrier multiplexing). Angle Modulation-Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

UNIT - II Effect of Noise in Analog Communication Systems 9

Review of probability and random process, Gaussian and white processes. Effect of noise in amplitude and frequency modulation systems. Effect of noise in angle modulation – Threshold Effect in angle modulation, Pre-emphasis and De-emphasis.

UNIT - III Pulse Modulation 9

Sampling process. Pulse Amplitude Modulation, Pulse position modulation, Pulse width modulation and Pulse Code Modulation. Delta modulation, Differential pulse code modulation, Line codes.

UNIT - IV Source and Channel Coding 9

Source coding – Shannon's Fano coding, Huffman coding, trade-off between Bandwidth and signal to noise ratio, Error control coding - linear block codes, Hamming codes and cyclic codes.

UNIT - V Digital Carrier Modulation Schemes 9

Digital Modulation Schemes - Binary ASK Signaling Schemes- Coherent ASK, Non-Coherent ASK. Binary PSK Signaling Schemes – Coherent PSK, Differentially coherent PSK. Binary FSK Signaling Schemes- Coherent FSK, Non-Coherent FSK. Comparison of Digital Modulation Schemes, Quadrature Amplitude Modulation. M-ary Signaling Schemes- M-ary coherent PSK, M- ary Differential PSK, M-ary wideband FSK Scheme.

Total Hours: **45**

References:

1 John G.Proakis,Masoud Salehi. (2011). *Communications Systems Engineering*. PHI Learning Pvt. Ltd. 2nd Edition.

2 Simon Haykin, Michael Mohar. (2007). *Introduction to Analog and Digital Communications.* John Wiley and Sons. 2nd Edition.

3 Taub H. and Schilling D.L. (2017). Principles of Communication Systems. Tata McGraw Hill. 4th Edition.

4 Roberto Togneri, Christopher J.S desilva. (2006). *Fundamentals of Information Theory and Coding Design*. A CRC Press company.

5 J.S Chitode. (2009*). Information Coding Techniques*. Technical publications, Pune.

6 K. Sam Shanmugam. (2017). Digital and Analog Communication Systems. Wiley India Pvt,Ltd.

Course Outcomes:

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

CO1: Distinguish different analog modulation schemes for their efficiency and bandwidth.

CO2: Predict the behavior of a communication system in presence of noise.

CO3: Investigate pulsed modulation system and analyze their system performance.

CO4:Interpret the need of coding and apply source and channel coding techniques.

CO5: Analyze different digital modulation schemes.

CO - PO MAPPING

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

Linear Integrated Circuits Laboratory

Semester: IV **Hours of Instruction/week: 3P**

Course Code: 24BELC12 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To design, simulate and implement linear and non-linear applications of operational amplifiers (Op-Amp), analog multipliers and PLL.

CLO2: To introduce the concepts of waveform generation and introduce some special function ICs.

List of Experiments:

1. Designing and testing of Inverting and Non Inverting Op-Amp
2. Op-Amp as Voltage Regulator
3. Op-Amp as Schmitt Trigger
4. Op-Amp as Comparator and Zero Crossing Detector
5. Op-Amp p-amp as Adder and Subtractor
6. Op-Amp as Differentiator and Integrator
7. Op-Amp as Precision Diode and Rectifier
8. Waveform Generation using Op-Amp
9. PLL Characteristics and Frequency Multiplier

Experiments using Simulation Software

1. Active LPF, HPF, BPF and BEF using Op-Amp
2. Multivibrator using 555 Timer
3. Instrumentation amplifier

Total Hours: **45**

Course Outcomes:

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

CO1: Design and test operational amplifier applications.

CO2: Design and simulate the applications of operational amplifier using simulation software.

CO3: Design, simulate and implement simple analog circuits using 555 timer.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	1	-	1	1	1	1	1
CO2	3	2	1	1	2	1	-	1	1	1	1	1
CO3	2	2	1	1	2	1	-	1	1	1	1	1

Analog and Digital Communication Laboratory

Semester: IV **Hours of Instruction/week: 3P**

Course Code: 24BELC13 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: Verify the learning and knowledge gained in Analog communication, Digital communication in the laboratory.

CLO2: To study the basic of simulation software in communication..

List of Experiments:

1. Time Division Multiplexing
2. AM Modulator and Demodulator
3. FM Modulator and Demodulator
4. Pulse Code Modulation and Demodulation
5. Pulse Amplitude Modulation scheme
6. Delta Modulation and Demodulation
7. Observation of signal constellations of BPSK, QPSK and QAM using simulation
8. Observation of signal constellations of QAM using simulation
9. ASK, FSK schemes using simulation
10. PSK and DPSK schemes using simulation
11. Study of Radiation Pattern of Antennas (Dipole, Folded Dipole)
12. Study of Radiation Pattern of Antennas (Yagi-Uda and Loop)

Total Hours: **45**

Course Outcomes:

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

CO1: Design, implement and evaluate different building blocks of Analog communication and digital communication systems.

CO2: Analyze the behaviour of modulators, demodulators.

CO3: Use simulation tools to observe constellation diagrams of digital modulation schemes and their behavior.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	2	1	-	1	2	1	2	1
CO2	2	2	1	1	2	1	-	1	2	1	2	1
CO3	2	2	1	1	2	1	-	1	2	1	2	1

School of Engineering

Essence of Indian Knowledge Tradition
(Non – Credit Mandatory Course)

(Applicable for the B.E students admitted from the academic year 2024-2025 & onwards)

Semester IV **Hours of Instruction/week: 3T**
Course Code: 24BEMC04

Course Learning Objectives (CLOs):

CLO1: Gain knowledge in Indian Philosophical Foundations.
CLO2: Know Indian Languages and Literature and the fine arts in India & their Philosophy.
CLO3: Explore the Science and Scientists of Medieval and Modern India.

UNIT - I Introduction to Indian Philosophy **9**

Basics of Indian Philosophy, culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian culture, Ancient Indian, Medieval India, Modern India.

UNIT - II Indian Philosophy & Literature **9**

Vedas Upanishads, schools of Vedanta, and other religion Philosophical Literature. Philosophical Ideas the role of Sanskrit, significance of scriptures to current society, Indian Philosophies, literature of south India. Indian languages and Literature-II: Northern Indian languages & Philosophical & cultural & literature.

UNIT- III Religion and Philosophy **9**

Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only).

UNIT- IV Indian Fine Arts & Its Philosophy (Art, Technology & Engineering) **9**

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in Indian, development of science in ancient, medieval and modern Indian.

UNIT - V Education System in India **9**

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Total Hours: **45**

References:

1. Kapoor, K. (2005). *Text and Interpretation: The India Tradition*.
2. *Science in Samskrit*. (2007). Samskrita Bharti Publisher.
3. NCERT – "*Position paper on Arts, Music, Dance and Theatre*".
4. Narain, S. (1993). *Examinations in Ancient India*.
5. Prakash, S. (1989). *Founders of Sciences in Ancient India*.
6. Mysore Hiriyanna. (2008). *The essentials of Indian philosophy*. Motilal Banarsidass Publishers.
7. Satischandra Chatterjee, & Dhirendra Mohan Datta. (2016). *An introduction to Indian philosophy*. Motilal Banarsidass Publishers Private Limited.

Course Outcomes:

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

CO1: Understand philosophy of Indian culture
CO2: Distinguish the Indian languages and literature among difference traditions
CO3: Learn the philosophy of ancient, medieval and modern India.
CO4: Acquire the information about the fine arts in India.
CO5: Know the contribution of scientists of different eras.

CO - PO MAPPING

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

Communication Skills

(For B.E. students admitted in 2024-2025 and onwards)

Semester IV **Hours of Instruction/week: 2T**

Course Code: 24BECS01

Course Learning Objectives (CLOs):

CLO1: To help learners achieve proficiency in language in various real time situations

CLO2: To enhance the communication skills of the learners through engaging activities and to encourage good reading habit among the students.

UNIT - I Effective Communication **6**

Active listening, focused discussion, body language, gestures

Ice-breaking Sessions (Group Work - oral): Self-introduction, Strengths and Weaknesses, Short term and long-term goals, Your Role Model – why – reasons.

Role play: Interview with a celebrity (M.S.Dhoni, Dr.Kalam, Amitabh Bachchan).

Brainstorming (Storm in a tea cup): Examples- Canteen food, How to make Maggie Noodles or a cup of tea – (with flow chart).

Discussion: Example topics- Open Book exams, What appeals to you in a person – Beauty or Brain? Enriching experience with a pet.

UNIT - II Creative Thinking and Communication **6**

7 Cs of Communication, Presentation Skills, Problem solving & decision making, resolving conflicts, Analyzing ability, organizing effectively.

Activities: Communication games, extempore, simulations for workplace conflicts, role plays for problem solving and decision-making, open-ended stories.

UNIT - III Comprehensive Skills & Vocabulary Enrichment **6**

Building comprehensive skills, Instances of its application, Anagrams, Homonyms, Homophones, Palindromes, Word Pyramid, Word Ladder, Linking words.

Activities: Listening comprehension, reading comprehension, summarizing a story and presentation, dramatization (Group) Critical Review of a movie, Enacting a play (contemporary themes/issues eg. Generation Gap, College Life, Problems faced by youth, etc.) Analysis of the plays Role Play (oral): Meeting a Bank Manager for Education Loan.

UNIT - IV Debating Skills and Oral Practice **6**

Enriching Public Speaking skills, Basics of debating, Dos & Don'ts in debate, Critical thinking and analysis, Types and elements of debate.

Activities: Mock debate sessions, Public speaking simulations, Oral team games and activities, criticism analysis.

UNIT - V Communication Skills (Practical) **6**

'Hands-on' In Communication Laboratory: Pronunciation practice, Listen and repeat, voice modulation, pitch, intonation, neutral accent.

Vocabulary Enrichment games: Dialogue completion, Language games on computer Crosswords, Find missing letters, industry-specific, domain specific articles for reading (from newspapers).

Planning/checklists (Oral and written): Meeting a service provider for Internet connection/data card/cellphone, organising a seminar/workshop, Your brother's engagement function.

Thinking out of the box for problem solving (Oral): Contextualized Jargon, If there is a bus strike, Bank strike, bus breakdown, You lost your purse while traveling, If someone tries to attack you.
Need-based Discussions: How to open an e mail account, Special features in Facebook, How to become member in FB, You Tube – advantages & disadvantages, Features in Google – News, Books, Scholar, Maps, etc.
Blogging: Expressing views, Case study – Dove soap or Vivel.

Total Hours: 30

Reference Books:

1. Ahuja, B.N. and S.S. Chopra. (1989). *Communication.* New Delhi: Surjeet Publications.
2. Butterfield, J. (2017). *Problem solving and decision making*. Boston, MA: Cengage Learning.
3. Collins, Patrick. (2009). *Speak with Power and Confidence*. New York: Sterling.
4. Fitikides, T. J. (1984). *Common Mistakes in English*. London: Orient Longman.
5. Hasson, Gill. (2012). *Brilliant Communication Skills.* Pearson Education, Great Britain.
6. Raman, Meenakshi & Sangeeta Sharma. (2011). *Technical Communication: Principles and Practice*. Second Edition, Oxford University Press New Delhi.

Course Outcomes:

Upon completion of this course, students will be able to:

- **CO1:** Demonstrate improved competence in oral and written communication
- **CO2:** Be prepared and respond to various situations effectively
- **CO3:** Adopt refined use of language in written communication
- **CO4:** Exhibit enhanced understanding of the professional use of English language
- **CO5:** Practice self-directed learning

Digital Signal Processing

Semester: V **Hours of Instruction/ week: 3T+1Tu**

Course Code: 24BELC14 **No. of credits: 4**

Course Learning Objectives (CLOs):

CLO1: To learn basics of DFT and how to apply the transform in Digital Signal Processing.

CLO2: Study the characteristics of digital filters and their realization using modern tools and hardware for various applications.

UNIT - I Discrete Fourier Transform **13**

Discrete Time Signals and Systems: Review - Discrete Fourier Transform: Definition – Properties – Circular convolution - Overlap add method and Overlap save method for computing convolution – Fast Fourier Transform – Radix 2 FFT – Decimation in time – Decimation in frequency – Computing inverse DFT by doing a direct DFT.

UNIT - II Design of Digital Filters **13**

IIR Filter - Properties - Design of analog Butterworth low pass filter – Analog Transformation of prototype LPF to BPF/BSF/HPF – Analog to Digital filter Transformation using Bilinear Transformation and Impulse Invariant method - FIR filters – Properties - Characteristics ofFIR filters with linear phase – Frequency response of linear phase FIR filters – Design of FIR filters using Window functions Rectangular, Hanning, Hamming, Blackman).

UNIT - III Realization of Digital Filters **10**

Direct, Cascade, Parallel and ladder realizations of IIR filters - Realization of FIR filters - Realization of Linear phase FIR filters

UNIT - IV Effects of Finite Register Length **12**

Input Quantization – Coefficient Quantization – Product Quantization – Signal Scaling – Finite register length effects in realization of IIR digital filters- Finite register length effects in realization of FIR digital filters.

UNIT - V Programmable Digital Signal Processor and Applications of DSP **12**

Introduction - Architecture of TMS320C67xx DSP - Addressing Modes - TMS320C67xx Instructions and Programming: Arithmetic and Logical Operations - Sample Programs –Real Time Applications of DSP.

Total Hours: 60

References:

1 John G.Proakis & Dimities & G.Manolakis. (2012). *Digital Signal processing principles algorithms and applications.* Prentice Hall of India. 4th Edition.

2 Sanjit K.Mitra. (2012). *Digital Signal Processing– A Computer Based Approach*. Tata Mc Graw Hill.

3 Oppenheim & Schafer. (2010). *Discrete time Signal processing.* Prentice Hall of India. 5thEdition.

4 P.Ramesh Babu. (2011). *Digital Signal Processing*. Scitech Publications. 4thedition.

5 B.Venkataramani & M.Bhaskar. (2012). *Digital Signal Processor Architecture, Programming and Application.* Tata McGraw Hill.

Course Outcomes:

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

CO1: Analyze the digital signals using various digital transforms DFT, FFT etc.

CO2: Design and develop IIR and FIR filters

CO3: Realize the structures of Linear Digital Filters.

CO4: Analyze Quantization effects of Finite Register Length in realization of Digital Filters.

CO5: Understand the architecture, properties and addressing modes of DSP processor and analyze the applications of it.

CO – PO MAPPING

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

Computer Architecture and Organization

Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BELC15 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the basic structure and operation of digital computer.
CLO2: To design the data path unit, control unit, various memory for interfacing and also parallel processing techniques.

UNIT - I Computer Organization & Instructions **9**

Basics of a computer system: Evolution, Ideas, Technology, Performance, Power wall, Uniprocessors to Multiprocessors. Addressing and addressing modes. Instructions: Operations and Operands, Representing instructions, Logical operations, control operations.

UNIT - II Arithmetic **9**

Fixed point Addition, Subtraction, Multiplication and Division. Floating Point arithmetic, High performance arithmetic, Subword parallelism.

UNIT - III The Processor **9**

Introduction, Logic Design Conventions, Building a Data path - A Simple Implementation scheme - An Overview of Pipelining - Pipelined Data path and Control. Data Hazards: Forwarding versus Stalling, Control Hazards, Exceptions, Parallelism via Instructions.

UNIT - IV Memory and I/O Organization **9**

Memory hierarchy, Memory Chip Organization, Cache memory, Virtual memory. Parallel Bus Architectures, Internal Communication Methodologies, Serial Bus Architectures, Mass storage, Input and Output Devices.

UNIT - V Advanced Computer Architecture **9**

Parallel processing architectures and challenges, Hardware multithreading, Multicore and shared memory multiprocessors, Introduction to Graphics Processing Units, Clusters and Warehouse scale computers - Introduction to Multiprocessor network topologies.

Total Hours: **45**

References:

1 P.Pal Chaudhuri. (2007).*Computer organization and design*. Prentice Hall of India.2nd Edition.

2 V.Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky.(2014).*Computer Organization*. Mc Graw-Hill Education India Pvt Ltd. 5th edition.

3 Morris Mano. (2017).*Computer system Architecture.* Pearson Education. Revised 3rd edition.

4 William Stallings. (2006).*Computer Organization and Architecture*. Pearson Education.7th Edition.

5 MilesJ.Murdocca.,&Vincent P. Heuring.(2015).*Computer Architecture and Organization: An Integrated approach***.**Wiley India Pvt Ltd, 7th edition.

Course Outcomes:

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

CO1: Describe data representation, instruction formats and the operation of a digital computer.

CO2: Illustrate the fixed point and floating-point arithmetic for ALU operation.

CO3: Discuss about implementation schemes of control unit and pipeline performance.

CO4: Explain the concept of various memories, interfacing and organization of multiple processors.

CO5: Discuss parallel processing technique and unconventional architectures.

CO - PO MAPPING

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

Control Systems

Semester: V **Hours of Instruction/Week: 3T**

Course code: 24BELC16 **No. of credits: 3**

Course Learning Objectives (CEOs):

CLO1: To characterize the control system.

CLO2: To discuss the use of control system components and analyze time response, frequency response and stability of open loop system and closed loop systems and also state variable models.

UNIT - I Systems and their Representation **9**

Basic elements in control system: open and closed loop system - Methods of analysis of Physical Systems: Electrical analogy of physical systems - AC & DC Servo Motor: Transfer function- Block diagram reduction techniques - Signal flow graph.

UNIT- II Time Response **9**

Time domain specifications - Standard test signals -Types and Order of the system- Time response of First and Second order Systems-Error coefficients, Generalized error series - Steady state error and error constants - Effect of P, PI, PD, PID controllers.

UNIT - III Frequency Response **9**

Frequency response of the system - Frequency domain specification - Bode plot: Relative stability analysis - Polar plot - Determination of closed loop response from open loop response : M and N circles - Nichol's Determination of closed loop response from open loop response, Nichol's Chart: Relative stability analysis - Correlation between frequency and time response.

UNIT - IV Stability of Control Systems **9**

Concept of Stability - Characteristics equation - Location of roots in S plane for stability - Routh Hurwitz Criterion - Root locus: Techniques, steps in obtaining a root-locus - Nyquist stability Criterion : gain margin & phase margin.

UNIT - V State Variable Representation **9**

State variable representation: SISO & MIMO systems - Conversion of State variable models to transfer functions - Conversion of transfer function to state variable, state models - Canonical variable methods - State transition matrix - Solution of state equations.

Total Hours: 45

References:

1 I.J.Nagrath M.Gopal.(2010).*Control system Engineering.* New Age International Publishers.4th Edition.
2 Ogata. K.(2009). *Modern Control Engineering.* Prentice Hall of India Ltd.
3 Kuo B.C.(2017). *Automatic Control Systems.* Prentice Hall of India Ltd.
4 Shinners S.M .*Modern Control Systems – Theory and Applications.* Addison Wesley Publishing Co. London.

Course Outcomes:

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

CO1: Understanding of mathematical representation of control systems.
CO2: Analyse the time domain responses and steady-state errors using different methods.
CO3: Formulate different types of analysis and plots in the frequency domain.
CO4: Evaluate the stability criteria using different plots.
CO5: Understand the state variable analysis of control systems.

CO - PO MAPPING

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

Embedded Systems

Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BELC17 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To learn the concept and architecture of ARM processor and the programming of ARM processor (LPC2148).

CLO2: To understand the concepts of Real-time Operating systems and communication protocols in embedded systems.

UNIT - I Introduction to Embedded System 9

Definition of Embedded System, Embedded Systems vs. General Computing Systems - Embedded system components - Embedded System Design Process, Classification of an Embedded System, Examples of an embedded system - Core of Embedded system, RISC vs. CISC controllers, Harvard vs. Von Neumann architecture.

UNIT - II ARM Processor and Peripherals 9

ARM Architecture Versions, ARM Architecture - Instruction Set, Stacks and Subroutines - Features of the LPC 214X Family, Peripherals, Timer Unit, Pulse Width Modulation Unit, UART.

UNIT - III Communication Bus Protocols for Embedded System 9

UART and SPI Communication Protocol, I2C Communication Protocol, Advantages & Disadvantages of I2C Protocols, USB Communication Protocol, PCI-bus Communication Protocol, CAN Protocol.

UNIT - IV Embedded C Programming 9

Overview of C Compiler and Optimization, Basic C data types, C Looping Structures, Register Allocations - Function Calls, Pointer Aliasing, Structure Arrangement, Bit-fields, Floating Point, Inline Functions, and Inline Assembly – C programs for General purpose I/O, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC.

UNIT - V Real-Time Operating Systems 9

Introduction to Real-time Operating Systems - Tasks and Task states, Tasks and Data - Semaphores, Message queues, Mailboxes and Pipes, Timer Functions - Events - Memory Management - Interrupt routines in an RTOS environment.

Total Hours: **45**

References:

1 Rajkamal. (2017). *Embedded Systems: Architecture, Programming and Design*. Tata McGraw Hill. 3rd Edition.

2 Steve Heath. (2023). *Embedded System Design*. Elsevier. 2nd Edition.

3 Frank Vahid & Givargis. (2006). *Embedded Systems Design: A Unified Hardware/Software Introduction*. Wiley Publications.

4 Jonathan W. Valvano. (2011). *Embedded Microcomputer Systems – Real Time Interfacing*. Cengage Learning. 3rd Edition.

5 Marilyn Wolf. (2012*). Computers as Components - Principles of Embedded Computing System Design.* Morgan Kaufmann Publisher (An imprint from Elsevier). 3rd Edition.

Course Outcomes:

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

CO1: Explain the design methodologies employed in embedded system design with an example.

CO2: Elaborate on ARM architecture and the built-in peripherals for application development.

CO3: Discuss and apply various Communication bus protocols.

CO4: Write Embedded C Programming for various application development.

CO5: Demonstrate the concept of real-time programming using tasks in RTOS.

CO - PO MAPPING

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

Antennas and Wave Propagation

Semester: V **Hours of Instruction/week: 3T+2P**

Course Code: 24BELC18 **No. of credits: 4**

Course Learning Objectives (CLOs):

CLO1: To design and measure variety of antennas for diverse applications.
CLO2: To evaluate wave propagation in various mediums.

UNIT - I Basic Antenna Concepts 9

Types of antennas, Radiation mechanism-Current distribution on thin wire antenna, Antenna parameters: Radiation Pattern, Radiation intensity, Radiation Power density, Directivity, Gain, Polarization, Bandwidth, Beam width, Friis Transmission formula.

UNIT - II Small Antennas and Array Antennas 9

Basic current element, Half-wave dipole antenna: Radiation resistance, Antenna Arrays: Array of two-point sources, Array of N element linear array: Broad side array, End fire array, Binomial array, Concepts of Phased array antenna, case study on Adaptive arrays.

UNIT - III Special Antennas 9

Qualitative discussion and applications of V and Rhombic Antenna, Loop Antenna, Yagi-Uda antenna, Turnstile antenna, Log periodic antenna, Helical antenna, Horn antenna, Reflector antennas and their feed systems, Microstrip Patch Antenna, Basics of MIMO antennas and beam forming.

UNIT - IV Antenna Measurements 9

Antenna measurement- test ranges- near field and far field measurements, measurement of gain, radiation pattern, directivity, impedance, polarization, VSWR. Challenges in measurements use of Anechoic chamber and EMI/EMC Chamber.

UNIT - V Wave Propagation 9

Modes of Propagation, structure of atmosphere, ground wave propagation, Tropospheric Propagation, Duct propagation, Troposcatter propagation, Sky wave propagation, Virtual height, Critical frequency, Maximum usable frequency, Skip distance, Fading and attenuation, Multi hop propagation.

Total Hours: **45**

List of Experiments using simulation software:

1. Design and obtain the parameters of a halfwave dipole antenna.
2. Design and obtain the parameters of a folded dipole antenna.
3. Design and obtain the parameters of a loop antenna.
4. Design and obtain the parameters of a Yagi-Uda array antenna.
5. Design and obtain the parameters of a helical antenna.
6. Design and obtain the parameters of a horn antenna.
7. Design and obtain the parameters of a microstrip patch antenna.
8. Design and obtain the parameters of a slot antenna.
9. Design and obtain the parameters of a broadside array antenna.
10. Design and obtain the parameters of an end-fire array antenna.

Total Hours: **30**

References:

1 Balanis E S. (2010). *Antenna Theory Analysis and Design*. John Wiley and Sons Inc.

2 Prasad K D. (2019). *Antennas and Wave Propagation*. Satyaprakashan Tech India Publications.

3 Harish A R and Scahidananda M. (2010). *Antennas and Wave Propagation*. Oxford University Press.

4 Edward C Jordan, Keith G Balmain. (2010). *Electromagnetic waves and Radiating systems*. Prentice Hall of India.

5 Balanis E S. (2010). *Antenna Theory Analysis and Design*. John Wiley and Sons Inc.

Course Outcomes:

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

CO1: Analyze antenna parameters.

CO2: Design and evaluate array antennas.

CO3: Design special purpose antennas for diverse applications.

CO4: Examine the behaviour of antennas by measurement.

CO5: Explain various modes of propagation of electromagnetic waves in free space.

CO - PO MAPPING

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

Digital Signal Processing Laboratory

Semester: V **Hours of Instruction/Week: 3P**

Course Code: 24BELC19 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To verify various operations like convolution, FFT, Quantization and apply the same.

CLO2: To design and implement FIR & IIR digital filters using software tools and DSPs as well as perform arithmetic operations on them

List of Experiments:

1. Overlap add and overlap save method for performing Convolution.
2. Implementation of FFT algorithm.
3. Implementation of amplitude modulation schemes using Simulink.
4. IIR Filter Design using bilinear transformation and impulse invariant technique.
5. FIR Filter design using windows.
6. Study of coefficient quantization effects on the frequency response of digital filter.
7. Addition and multiplication using Digital Signal Processor.
8. Subtraction and division using Digital Signal Processor.
9. Implementation of linear convolution and circular convolution using Digital Signal Processor.
10. Implementation of FIR filter using Digital Signal Processor

Total Hours: **45**

Course Outcomes:

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

CO1: Perform operations like convolution, FFT, and Quantization and apply the same to signal processing.

CO2: Design digital filters using various DSP processors and implement the same.

CO3: Verify and Analyze arithmetic operations and finite word length effect on DSP systems.

CO - PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	3	-	-	-	2	2	1	1
CO2	2	2	2	1	3	-	-	-	2	2	1	1
CO3	2	2	2	-	3	2	-	-	2	2	1	1

Embedded Systems Laboratory

Semester: V **Hours of Instruction/week: 3P**

Course Code: 24BELC20 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To learn Embedded C for reading and writing data from port pins.
CLO2: To program and interface with I/O devices and enable serial communication with external devices..

List of Experiments:

Using ARM Processor (LPC2148)

1. Program to read switch status and display in-point LEDs and LEDs Blinking.
2. Interfacing with LCD.
3. Interfacing with Seven segment display.
4. Waveform generation using DAC.
5. Interfacing of Analog to Digital Converter (ADC).
6. Pulse Width Modulation (PWM) waveform generation.
7. Temperature sensor interface.
8. Interfacing Internal Rime Time Clock (RTC).
9. Serial communication using UART.
10. Relay Interface.
11. Interfacing of stepper motor.
12. Study of External Interrupts.

Total Hours: **45**

Course Outcomes:

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

CO1: Write an embedded C code for interfacing ARM processors with I/O peripherals such as LED, LCD, Sensors, and Motors.
CO2: Perform the ADC and DAC conversions using ARM processor.
CO3: Demonstrate the serial communication between the devices using an ARM processor.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	3	-	-	-	2	2	-	1
CO2	2	2	3	2	3	-	-	-	2	2	-	1
CO3	2	2	3	2	3	-	-	-	2	2	-	1

Advanced Digital System Design

PE1 - Semester: V **Hours of Instruction/Week:3T**

Course code: 24BELE01 **No. of credits:3**

Pre–Requisite: Digital system design.

Course Learning Objectives (CLOs):

CLO1: To design and analyze synchronous and asynchronous sequential circuits.

CLO2: To study the deign process of PLD, CPLDs, FPGAs and design simple applications using VHDL.

UNIT-I Synchronous Sequential Circuit Design 9

Analysis of clocked synchronous sequential circuits and modeling- State diagram, state table, state table assignment and reduction-Design of synchronous sequential circuits - Design of iterative circuits-ASM chart and realization using ASM.

UNIT-II Asynchronous Sequential Circuit Design 9

Analysis of asynchronous sequential circuit – flow table reduction-races-state assignment- transition table and problems in transition table- design of asynchronous sequential circuit-Static, dynamic and essential hazards – mixed operating mode asynchronous circuits – designing ending machine controller.

UNIT-III Design Using Programmable Logic Devices 9

Programming logic device families – Designing a synchronous sequential circuit using PLA/PAL– Realization of finite state machine using PLD - Complex PLDs (CPLD) - Introduction, Basic Architecture, Design flow, Xilinx XC3000 & XC4000 Architectures, Actel Architectures, ALTERA's FLEX 8000, and ALTERA's FLEX 10000 FPGAs.

UNIT-IV FPGAs 9

Introduction to Field Programmable Gate Arrays – Types of FPGA-Xilinx XC3000series –Logic Cell array (LCA) - Configurable Logic Blocks (CLB) - Input/output Block (IOB) - Programmable Interconnect Point (PIP) - Introduction to Xilinx XC4000 family.

UNIT-V System Design Using VHDL 9

VHDL operators – Arrays – concurrent and sequential statements – packages- Data flow – Behavioral – structural modeling – compilation and simulation of VHDL code –Test bench - Realization of combinational and sequential circuits using VHDL – Registers – counters – sequential machine – serial adder – Multiplier- Divider – Design of simple microprocessor.

Total Hours :**45**

References:

1. Charles H Roth.(2004).*Fundamentals of Logic Design.* Thomson Learning.
2. Parag K. Lala.(2003).*Digital system Design using PLD.* BS Publications.
3. Charles H Roth Jr.and Larry L Kinney.(2013).*Digital System Design using VHDL*. Cengage learning.
4. J.Bhaskar.(2015).*AVHDLSynthesis Primer*.PearsonEducation.2nd Edition.
5. J.Bhaskar.(2018).*A Verilog HDL Primer.* Star Galaxy Publishing. 3rd Edition.

Course Outcomes:

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

CO1 : Analyze and design synchronous sequential circuits.

CO2 : Design asynchronous sequential circuits.

CO3 : Study the basics of Programmable logic device.

CO4: Understand the concepts of FPGA.

CO5: Apply VHDL for simple digital systems.

CO-PO MAPPING

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

Electronic Measurements and Instrumentation

PE1 - Semester: V **Hours of Instruction/week:3T**

Course Code:24BELE02 **No.ofcredits:3**

Pre–Requisite: Basic digital and analog electronics.

Course Learning Objectives(CLOs):

CLO1: To explain the importance of measurement systems and working of measuring instruments.

CLO2: To analyze various signal analyzers to create electronic instruments virtually for the automation and telecommunication applications.

UNIT-I Basic Measurement Concepts 9

Measurement systems – Static and dynamic characteristics –units and standards of measurements– error: - accuracy and precision, types, statistical analysis – moving coil, moving iron meters – multimeter – Bridge measurements: – Maxwell, Hay, Schering, Wien bridge.

UNIT-II Basic Electronic Measuring Instruments 9

IoT based measuring instruments: Electronic multimeter – Cathode ray oscilloscopes – block schematic – applications – special oscilloscopes: – delayed time base oscilloscopes, analog and digital storage oscilloscope – Q meters – Vector meters – RF voltage and power measurements – True RMS meters – LCR meters.

UNIT-III Signal Generators and Analyzers 9

IoT based generators and analyzers: Function generators – pulse and square wave generators, RF signal generators – Sweep generators – Frequency synthesizer – wave analyzer – Harmonic distortion analyzer – spectrum analyzer - digital spectrum analyzer – Logic analyzer.

UNIT-IV Digital Instruments 9

Comparison of analog and digital techniques – IoT based digital instruments: digital voltmeter – digital energy meter – multimeters –frequency counters – measurement of frequency and time interval – extension of frequency range – Automation in digital instruments, fully automatic digital instruments, Computer controlled test systems, Elements of a digital data acquisition system.

UNIT-V Virtual Instruments 9

Introduction - Block diagram of a virtual instrument - Physical quantities and Analog interfaces- Design of virtual instruments like Function generator, oscilloscope and data acquisition system via RS232/serial port using LabView.

Total Hours:**45**

References:

1 Albert D.Helfrick and William D. Cooper.(2007).*Modern Electronic Instrumentation and Measurement Techniques*. Pearson/Prentice Hall of India.

2 Ernest O.Doebelin.(2007).*Measurement Systems-Application and Design*. TMH.

3 JohnF.C.Whitfield.(2021).*Electronic Measurement and Instrumentation.* CRC Press. 2nd Edition.

4 David A.Bell.(2023).*Electronic Instrumentation and Measurements*. Oxford University Press.5th Edition.

5 Bernard M.Oliver, John M.Cage.(2022).*Electronic Measurement and Instrumentation*. McGraw Hill Education. 6th Edition.

Course Outcomes:

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

CO1: Classify the performance characteristics of each instrument.

CO2: Apply fundamental principles of electronics to accurately measure various electrical parameters using electronic measuring instruments.

CO3: Explain about types of signal generators and analyzers.

CO4: Understand the use of digital instruments in measurement of electrical parameters.

CO5: Design the electronic instruments in Virtual Instruments using LabVIEW for automation applications.

CO-PO MAPPING

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

Quantum Electronics

PE1 - Semester: V **Hours of Instruction/week:3T**

Course Code:24BELE03 **No.ofcredits:3**

Pre–Requisite: Physics, laser and Non-linear optics.

Course Learning Objectives (CLOs):

CLO1: To understand the concepts of basic Quantum electronic devices.
CLO2: To acquire knowledge on laser, nonlinear optics second order effects and types of states.

UNIT-I Quantum electronic devices 9

Quantum electronic devices - Short channel MOS transistor - Split gate transistor - Electron wave transistor-Electronwavetransistor-Electronspintransistor-Quantumcellularautomata-Quantum dot array, Quantum memory.

UNIT-II Laser 9

Gaussian beam in a homogenous medium, Gaussian beam in a lens waveguide, Elliptic Gaussian beams, Optical resonators, Spontaneous and induced transitions, gain coefficient, homogenous and inhomogeneous broadening.

UNIT-III Nonlinear Optics 9

Introduction to nonlinear (NL) optics, 2nd order NL effects-The nonlinear optical susceptibility tensor, Second harmonic generation, parametric oscillations, parametric amplifiers, Applications– Nonlinear polarization –physical origin Complex notation, conservation laws-Second Harmonic Generation, Birefringence and Quasi-Phase Matching-3 rd order NL effects-Self-Phase Modulation, Optical solution- Stimulated Raman Scattering-Electro-optic (EO) modulation of light Linear EO effect, Phase retardation- Amplitude, and Phase modulation-Traveling wave modulator.

UNIT-IV Second order effects 9

Second harmonic generation, Sum and difference frequency generation, Parametric amplification, parametric fluorescence and oscillation Concept of quasi phase matching; Periodically poled materials and their applications in nonlinear optical devices.

UNIT-V States 9

Quantization of the electromagnetic field; Number states; Coherent states and their properties; Squeezed states of light and their properties; Application of optical parametric processes to generate squeezed states of light; Entangled states and their properties; information science quantum information science.

Total Hours:**45**

References:

1 Amnon Yariv.(2012).*Quantum Electronics*. Wiley India Pvt Ltd.4th Edition.
2 David Klyshko.(2011).*Physical Foundations of Quantum Electronics*. World Scientific.
3 Harisson Paul.(2011).*Quantum Wells.* Wires and Dots. Wiley.
4 Jones and Bartlett, Ma.(2006).*The Quantum Challenge*. USA.
5 *Quantum Optics: An Introduction.*(2006). M. Fox, Oxford Univ. Press
6 R Shen, John Wiley.(1988). *Principles of Nonlinear Optics.* Singapore.

Course Outcomes:

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

CO1: Understand the concepts of Quantum electronic devices.
CO2: Illustrate the types of lasers and its characteristics.
CO3: Analyse the characteristics of non-linear optics.
CO4: Explain the concepts of second order harmonic.
CO5: Discuss on different types of states of light.

CO-PO MAPPING

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

Nano and Flexible Electronics

PE1 - Semester: V **Hours of Instruction/week:3T**

Course Code:24BELE04 **No. of credits:3**

Pre–Requisite: Engineering Physics, Electronic Devices and Circuits.

Course Learning Objectives (CLOs):

CLO1: To enable the students to learn the basics of nano science and nanotechnology.
CLO2: Understand the materials and methods used for fabrication of flexible electronics.

UNIT-I Introduction to Nano Electronics 9

Electronic states in crystal energy bands, Concepts of 2D nanostructures (quantum wells), 1D nanostructures (quantum wires), 1D nanostructures (quantum dots), artificial atomic clusters, Size dependent properties, Size dependent absorption spectra, Blue shift with smaller sizes, Phonons in nanostructures.

UNIT-II Basics of Flexible Electronics 9

Introduction to Flexible and Printed Electronics and their Materials Systems, Back ground and history, emerging technologies, general applications, Review of Semiconductors and Circuit Elements, Carrier transport, doping, band structure, thin-film electronic devices.

UNIT-III Flexible Devices Fabrication and Materials 9

Thin-film Deposition and Processing Methods for Flexible Devices, CVD, ECVD, PVD, etching, photolithography, low-temperature process integration, Materials for Flexible and Printed Electronics: Nanowire and nano particle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, paper-based electronics, textile substrates, barrier materials.

UNIT-IV Thin Film Transistors 9

Thin Film Transistors device structure and performance: I-V characteristics, Mechanics of Thin-films and Flexible Thin-film Transistors: thin-film mechanics models, neutral plane, conformal electronics, mechanical modeling.

UNIT-V Applications and Economics 9

Flexible Electronics Applications: Displays, sensor arrays, memory devices, MEMS, lab-on-a- chip, and photovoltaic, Introduction to Cost Models and Economics of Printed Flexible Electronics: Overview of display industry cost models, cost advantages and disadvantages for printed electronics, Scaling of large-area flexible systems, cost of goods sold for display applications.

Total Hours:**45**

References:

1 Takao Someya. (2013). *Stretchable Electronics*. Wiley International, U.S.

2 Guozhen Shen, Zhiyong Fan.(2016).*Flexible Electronics: From Materials to Devices*. World Scientific, U.S.

3 Chuan Seng Tan, Qing Zhang, Wei Lei.(2021).*Nano electronics: Materials, Devices, Applications and Challenges* .Springer.

4 George K. Knopf, Sergey Edward Lyshevski.(2022).*Flexible Electronics: Materials and Applications.* CRC Press.

5 Chris Dwyer.(2023).*Nano and Flexible Electronics: Materials, Devices, and Applications*. Wiley.

6 Omar Manasreh.(2024).*Nanotechnology and Nanoelectronics: Principles, Devices, Measurements, and Applications*. CRC Press.

7 Stergios Logo thetidis.(2023).*Flexible and Nano-Electronics: Principles, Materials, and Applications*. Springer.

Course Outcomes:

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

CO1: Interpret technical information about the basics of nano electronics.

CO2: Understand the materials, fabrication techniques and design principles specific to Flexible electronic devices.

CO3: Designlayouts,exemplarycircuitsandflexibleelectronicdeviceswiththegained Knowledge on flexible electronic materials and technology.

CO4: Analyse the characteristics and performance metrics of TFT's.

CO5: Indicate main objectives and application areas of flexible electronics with an Understanding of their economics.

CO-PO MAPPING

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

Fundamentals of IoT

PE2 - Semester: V **Hours of Instruction/week:3T**

Course Code: 24BELE21 **No. of credits:3**

Pre– Requisite: Fundamentals of IoT, network, Protocol survey and Communication models.

Course Learning Objectives (CLOs):

CLO1: To Understand the fundamentals of Internet of Things, network and Communication aspects.

CLO2: To Explore the domain applications of Internet of Things.

UNIT-I Introduction to IoT **9**

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs.

UNIT-II IoT&M2M **9**

Machine to Machine, Difference between IoT and M2M,Software define Network.

UNIT-III Network& Communication aspects **9**

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination. Challenges in IoT Design challenges, Development challenges, Security challenges, other challenges.

UNIT-IV Tools for IoT application development **9**

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.

UNIT-V Domain specific applications of IoT **9**

Home automation, Industry applications, Surveillance applications, Other IoT applications.

Total Hours:**45**

References:

1 Arshdeep Bahga &Vijay Madisetti.(2015).*Internet of Things–A hands-on approach.* Universities Press.

2 Manoel Carlos Ramon.(2014).*Intel Galileo and Intel Galileo Gen2:API Features and Arduino Projects for Linux Programmers.* Apress.

3 Marco Schwartz.(2014).*Internet of Things with the Arduino Yun*.Packt Publishing.

4 Cuno P fister. (2011).*Getting Started with the Internet of Things.* O"Reilly Media.

5 Waltenegus Dargie & Christian Poellabauer**.** (2011). *Fundamentals of Wireless Sensor Networks: Theory and Practice.* John Wiley & Sons Pvt. Ltd.

Course Outcomes:

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

CO1: Discuss the fundamentals of Internet of Things.

CO2: Illustrate the performance of IoT and M2M, Software define Network.

CO3: Elaborate the concepts of Network & Communication aspects.

CO4: Understand and develop Internet of Things applications through different tools.

CO5: Explore the domain applications of Internet of Things.

CO-PO MAPPING

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

Operating Systems

PE2 - Semester: V **Hours of Instruction/week:3T**

Course Code:24BELE22 **No. of credits:3**

Pre–Requisite: C++ & Data structures.

Course Learning Objectives (CLOs):

CLO1: To discuss the basic architectural components of operating system in handling processes and resource management.
CLO2: To understand the concept of deadlocks and analyze various memory management Schemes.
CLO3: To learn the basics of Linux system and its applications.

UNIT-I Operating System Overview **9**

Operating System Structure - OS operations- OS services- System calls- Types of system calls - Process Concept- Process Scheduling- Operations on Process- Threads - Multithreading Models- Threading Issues.

UNIT-II Process Synchronization and Scheduling **9**

Process synchronization-Critical Section Problem-Synchronization Hardware Semaphores-Classical Problems of synchronization- CPU scheduling- Scheduling Criteria- Scheduling algorithms - Thread Scheduling –Deadlocks- Deadlock characterization- Methods for handling deadlock- Deadlock Prevention- Deadlock Avoidance- Deadlock detection.

UNIT-III Memory Management **9**

Background-Swapping-Contiguous memory allocation-Paging-Segmentation-Virtual memory Management- Background- Demand Paging- Page Replacement - Memory management files.

UNIT-IV Storage Management **9**

Mass storage structure- Disk structure- Disk scheduling- Disk Management – Swap space management- File Concept- Access methods- Directory and disk structure- File system Mounting- File Sharing- Protection- File System Implementation- Directory Implementation- Allocation methods- free space management.

UNIT-V Case Study **9**

Linux overview- Administration- Kernel Architecture- Process- memory- file and I/O Management- Mobile OS - Symbian OS- Linux for mobile devices- Android.

Total Hours:**45**

References:

1 Sibsankar Haldar. AlexA. Aravind.(2010).*Operating Systems*. Pearson Publication.

2 Ann Mclver Mc Hoes.(2011).*Understanding Operating Systems*. Course Technology-Cengage Learning Publisher.6th Edition.

3 Abraham Silberschatz.Peter B.Galvin.Greg Gagne.(2013).*Operating System Concepts.* WileyPublisher.9th Edition.

4 Gary Nutt.(2021).*Operating Systems: A Modern Perspective.* Pearson Publisher.4th Edition

5 Andrew S.Tanenbaum, Herbert Bos.(2022).*Modern Operating Systems*. Pearson Publisher. 5th Edition

6 Randal E.Bryant, David R.O' Hallaron.(2022).*Operating Systems: Principles and Practice*. Pearson Publisher. 2nd Edition.

Course Outcomes:

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

CO1: Describe-contrast and compare differing structures for operating systems.

CO2: Understand and analyze theory and implementation of processes and scheduling.

CO3: Identify the resource management techniques for efficient memory management in distributed applications.

CO4: Explain storage management.

CO5: Discuss the architecture and functioning of operating systems (Linux and Android) used in mobile devices.

CO-PO MAPPING

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

Programming Languages

PE2 - Semester: V **Hours of Instruction/week:3T**

Course Code:24BELE23 **No. of credits:3**

Pre–Requisite: Basic C Programming.

Course Learning Objectives (CLOs):

CLO1: To learn about the properties, data types, control structuring in a programming language.
CLO2: To understand concept of storage management and distributed processing.

UNIT-I Introduction 9

Language Design Issues: Short History of Programming Languages-Role of Programming Languages-Programming Environments Impact of Machine Architectures-Operation of a Computer -Virtual Computers and Binding Times-Language Translation Issues: Programming Language Syntax, Stages in Translation, Formal Translation, Models, Recursive Descent Parsing.

UNIT-II Language Properties and Data Types 9

Modelling Language Properties: Formal Properties of Languages - Language Semantics. Elementary Data Types: Properties of Types and Objects -Scalar Data Types - Composite Data Types - Encapsulation: Structured Data Types, Abstract Data Types, Encapsulation by Subprograms - Type Definition - Inheritance: Abstract Data Types Revisited – Inheritance - Polymorphism.

UNIT-III Control 9

Sequence Control: Implement and Explicit Sequence Control-Sequence with Arithmetic Expressions -Sequence Control between Statements-Sequencing with Non-Arithmetic Expressions-Subprogram Control: Sub program Sequence Control-Attributes of Data Control–Parameter–Transmission -Explicit Common Environment.

UNIT-IV Management 9

Storage Management: Elements Requiring Storage – Programmer and System- Controlled Storage – Static Storage Management - Heap Storage Management.

UNIT-V Distributed Processing and Network Programming 9

Distributed Processing: Variations on Subprogram Control - Parallel Programming – Hardware – Developments - Software Architecture - Network Programming: Desktop Publishing - World Wide Web.

Total Hours:**45**

References:

1 Michael L.Scott.(2015).*Programming Language Pragmatics*. Morgan Kaufmann.

2 Robert W.Sebesta.(2015). *Concepts of Programming Languages*. Pearson.

3 AlfredV.Aho,MonicaS.Lam,RaviSethi,andJeffreyD.Ullman.(2006).*Compilers: Principles, Techniques and Tools.* Pearson.

4 Terrence W.Pratt MarvinV. Zelkowitz. *Programming languages–Design and Implementation.* Prentice Hall of India. 3rd Edition.

5 Seyed H. Roosta .*Fundamentals of Programming Languages, Design &Implementation.* Vikas publications.

Course Outcomes:

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

CO1: Understand the structure of computer operation and basic programming concepts.

CO2 : Explain the concepts of variables, data types and operators in programming languages.

CO3: Analyze the sequence control of the program and implement the concepts of inheritance and polymorphism.

CO4: Design and implement storage management solutions for real-world programming tasks.

CO5: Explore hardware developments relevant to distributed processing such as multicore Processors and distributed memory architecture.

CO-PO MAPPING

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

Digital Switching Systems

PE2 - Semester: V **Hours of Instruction/week:3T**

Course Code:24BELE24 **No. of credits:3**

Pre–Requisite: Computer Networks.

Course Learning Objectives (CLOs):

CLO1: To understand and learn various entities of networks and transmission of data in Telecommunication networks.
CLO2: Acquire knowledge on types of switching and its application.

UNIT-I Introduction **9**

Overview of existing Voice, Data and Multimedia Networks and Services; Review of Basic Communication principles; Synchronous and Asynchronous transmission, Line Codes.

UNIT-II Trunk Transmission **9**

Multiplexing &Framing-types and standards; Trunk signaling; Optical Transmission-line codes and Muxing: SONET/SDH; ATM; Microwave and Satellite Systems.

UNIT-III Local Loop Transmission **9**

The Analog Local Loop; ISDN local loop; DSL and ADSL; Wireless Local Loop; Fiber in the loop; Mobile and Satellite Phone local loop.

UNIT-IV Switching **9**

Evolution; Space switching, Time switching and Combination Switching; Blocking and Delay characteristics; Message ,Packet and ATM switching; Advances in switching techniques – shared memory fast packet switches, shared medium fast packet switches and space division fast packet switches, Photonic switching - Optical TDM, WDM.

UNIT-V Tele traffic Engineering **9**

Telecom Network Modeling; Arrival Process; Network Blocking performance; Delay Networks Queuing system analysis and delay performance.

Total Hours:**45**

References:

1 J.Bellamy. (2003).*Digital Telephony*. John Wiley.3rd Edition.

2 N.Saadawi,M.H.Ammara & A.E.Hakeem.(1994).*Fundamentals of Telecommunication Networks*. Wiley Interscience.

3 A.Thompson.(2000). *Telephone switching Systems*. Artech House Publishers.

4 W.D.Reeve.(1995).*Subscriber Loop Signalling and Transmission Handbook*. IEEE Press (Telecomm Handbook Series).

5 Tarmo Anttalaien.(2003).*Introduction to Telecommunication Network Engine*. Artech House.2nd Edition.

Course Outcomes:

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

CO1: Explain the various types of transmission and switching techniques.

CO2: Describe the various multiplexing and switching concepts for telecom systems.

CO3: Analyse the types of loops and their performance.

CO4: Define the technologies associated with the data switching operations.

CO5: Understand the basics of telecommunication networks and digital transmission of data.

CO-PO MAPPING

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

School of Engineering

Design Thinking
(Non – Credit Mandatory Course)

(Applicable for the B.E students admitted from the academic year 2024-2025 & onwards)

Semester: V **Hours of Instruction/week: 1T+2P**

Course Code: 24BEMC05

Course Learning Objectives (CLOs):

CLO1: To provide the new ways of creative thinking.

CLO2: To learn the innovation cycle of Design Thinking process for developing innovative products.

UNIT - I An Insight to Learning **9**

Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting, Remembering Memory: Understanding the Memory process, Problems in retention, Memory enhancement techniques, Emotions: Experience and Expression: Understanding Emotions: Experience and Expression, Assessing Empathy, Application with Peers.

UNIT - II Basics of Design Thinking **9**

Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts and Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test. Being Ingenious and Fixing Problem: Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving.

UNIT -III Process of Product Design **9**

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and 15 functions, Assignment – Engineering Product Design Prototyping and Testing: What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

UNIT- IV Celebrating the Difference **9**

Understanding Individual differences and uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences. Design Thinking and Customer Centricity: Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

UNIT- V Feedback, Re-Design and Re-Create **9**

Feedback loop, Focus on user Experience, Address ergonomic challenges, user focused design, rapid prototyping and testing, final product, final Presentation, Solving Practical Engineering Problem through Innovative Product Design and Creative Solution.

Total Hours: **45**

References:

1. Burgelman, R. A., Christensen, C., & Wheelwright, S. C. (2009). *Strategic Management of Technology and Innovation*. McGraw-Hill/Irwin.
2. Idris Mootee. (2013). *Design Thinking for Strategic Innovation*. John Wiley & Sons.
3. Martin, R. L. (2009). *The design of business: Why design thinking is the next competitive advantage.* Harvard Business Press.
4. Hasso Plattner, Christoph Meinel, & Leifer, L. (2015). *Design Thinking Research: Building Innovators*. Springer International Publishing.
5. Liedtka, J., King, A., & Bennett, K. (2013). *Solving Problems with Design Thinking Ten Stories of What Works.* New York; Chichester, West Sussex Columbia University Press.
6. Asmaraningtyas, L.W., Rahmawati, I.D., & Fitriyah, H. (2024). *Green Business Innovation: Sustainable Business Model Development through Integration of Business Model Canvas, Design Thinking, and Islamic Business Ethics.* Golden Ratio of Marketing and Applied Psychology of Business.

Course Outcomes:

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

CO1: Compare and classify the various learning styles and memory techniques and apply them in their engineering education Discuss the characteristics of semiconductor diodes.

CO2: Analyze and inspect emotional expressions in designing products.

CO3: Develop new ways of creative thinking.

CO4: Propose real-time innovative engineering products designs and choose appropriate frameworks, strategies, techniques during prototype development..

CO5: Perceive individual differences and its impact on everyday decisions and further create a better customer experience.

CO - PO MAPPING

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

Soft Skills

(For B.E. students admitted in 2024-2025 and onwards)

Semester V **Hours of Instruction/week: 2T**

Course Code: 24BESS01

Course Learning Objectives (CLOs):

CLO1: To encourage all round development of students and to develop the right attitude through individual and group activities.

CLO2: To help students understand self and other's personality better, to maintain a positive attitude and stay motivated all the time.

UNIT- I Attitude Development **6**

Self Esteem & Attitude testing, Developing a positive attitude, Attitude in the workplace, Adaptability.

Activities: Psychometrics, Inspirational Stories, Role Playing, quiz, Interactive and Feedback Exercises.

UNIT - II Goal Setting & Leadership Skills **6**

Guidelines for Goal setting, SMART Goals, Types of goals, Personal & Professional goals, Long term & Short term goals.

Qualities of a Leader, Strategies for Effective Time Management, Problem solving & decision making, Leadership & Assertiveness.

Activities: Listing of goals (Academic, Health, Financial & Social), Goal measurement – self audit exercise, Leadership test, simulations, team games.

UNIT - III Communication at the Workplace **6**

Small talk, dialogue, debate, discussion, overcoming shyness, hesitation and cultural codes, interview techniques, group discussions, oral presentation skills, listening and observational Skills, body language, Intermediary Communication, Event Management, overcoming mental blocks, prejudices, developing proficiency in communicating through telephone, tele-conferencing, Web Chat etc.

Activities: Public Speaking Exercise on any topic of choice, Situational games, Mock Interview, Book Review, Biographical Sketch and Presentation, Group Discussion, Exercise on Current Affairs and Social Issues, Role Playing Exercise to highlight Non Verbal Skills.

UNIT - IV Stress Management and Emotional Intelligence Skills **6**

Change and stress, General principles of stress management, stress coping ability and stress inoculation training,

Emotional intelligence and Change Management, Dealing with crisis and disasters, concepts of Emotional Intelligence, conflict stimulation and conflict resolution techniques for effective management.

Activities: Exchange of Personal anecdotes, Psychometrics, Team Games Games like Were Wolf, Win Win Team Negotiation Exercise

UNIT - V Employability Quotient **6**

What is employability quotient, how to raise your employability quotient, employment readiness

Preparation for employment- roadmap to employment, drafting a CV, Group discussion & interview training

Activities: Hands on job search training, aptitude training, CV building, GD recording and Mock interview sessions

Total Hours: 30

Reference Books:

1. Bhatia, R.L. (1994). *Managing Time for a Competitive Edge*. A H Wheeler Publishing.
2. Prasad, H. M. (2001). *How to Prepare for Group Discussion and Interview*. New Delhi: Tata McGraw-Hill Publishing Company Limited.
3. Raman, Sharma. (2011). *Technical Communication*. Oxford University.
4. Rao, M.S. (2013). *Soft Skills – Enhancing Employability: Connecting Campus with Corporate*. SRS books.
5. Sabina Pillai & Agna Frenandez. (2018). *Soft Skills & Employability Skills.* Cambridge University Press.
6. Tim Hindle. (2009). *Reducing Stress, Essential Managers.* DK Publishers.

Course Outcomes:

Upon completion of this course, students will be able to:

- **CO1:** Illustrate increased awareness about the self
- **CO2:** Display enhanced knowledge of social and professional etiquette
- **CO3:** Work effectively in teams
- **CO4:** Practice positive thinking in interpersonal relationships
- **CO5:** Acquire confidence in stress management and cultivate emotional intelligence

VLSI Design

Semester: VI **Hours of Instruction/Week: 3T**

Course Code: 24BELC21 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To familiarize the basic concepts of VLSI design process, fabrication techniques, properties and behaviour of MOS devices.

CLO2: To learn to design various logic units for integrated circuits.

CLO3: To comprehend the need for low power and the importance of power analysis and estimation techniques in VLSI.

UNIT - I Overview of VLSI Design Methodology 9

VLSI design process - Architectural design - Logical design - Physical design - Layout styles - Full custom - Semi custom approaches.

Fabrication Techniques: An overview of wafer fabrication-Wafer Processing-Oxidation- Patterning-Diffusion-Ion implantation-Deposition-Silicon gate nMOS process-CMOS processes- nWell- pWell-Twin Tub-Silicon on insulator.

UNIT - II Basic Electrical Properties of MOSFET 9

NMOS and PMOS transistors- Threshold voltage - Threshold voltage equations- MOS device equations - Basic DC equations - Second order effects. **Inverters:** NMOS inverter - Depletion mode and enhancement mode pull ups-Pseudo nMOS Inverter - CMOS inverter – Transfer Characteristics – Noise Margins- Sheet resistance - Area Capacitance - Inverter delay.

UNIT - III Logic Design 9

Static CMOS logic - Pass transistor- transmission gate logic - NAND gate - NOR gate - Other forms of CMOS logic - Dynamic CMOS logic - Clocked CMOS logic - Precharged domino CMOS logic - Structured design - Simple combinational logic design examples - Parity generator – Multiplexer - Clocked sequential circuits - Two phase clocking - Charge storage - Dynamic register element –D-Flip Flop -Semi static register - JK flip flop - Dynamic shift register.

UNIT - IV Subsystem Design Process 9

Design of a 4-bit shifter - General arrangement of a 4-bit arithmetic processor - Design of an ALU subsystem - Implementing ALU functions with an adder - Carry look ahead adder - Multipliers - Serial parallel multiplier – Pipelined multiplier array - Booth's Algorithm-Booth’s Encoder-Modified Booth's algorithm.

UNIT - V Low Power VLSI Design **9**

Introduction to low power VLSI design-Need for low power- Basic principles of low power design -Sources of Power dissipation.

Power Analysis and Estimation Techniques: Power Analysis-Gate level analysis-Architecture level analysis-Probabilistic Power Analysis-Power Estimation-Circuit level–-High level power estimation.

Total Hours: **45**

References:

1 Jan M Rabaey & Anantha Chandrakasan & B.Nikolic. **(**2016). *Digital Integrated Circuits:A Design Perspective*. Prentice Hall of India. 2nd Edition.

2 Douglas A. Pucknell & Kamran Eshraghian. (2017). *BASIC VLSI Design*. Prentice Hall of India. 3rd Edition.

3 Wayne Wolf. (2011). *Modern VLSI Design: IP Based Design*. Prentice Hall. 4th Edition.

4 M.J. Sebastian Smith. (2012). *Application Specific Integrated Circuits*. Addison Wesley. 3rd Edition.

5 Kaushik Roy & Sharat C. Prasad (2011). *Low Power CMOS VLSI circuit Design.* John Wiley & Sons. 2rd Edition.

Course Outcomes:

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

CO1: Illustrate VLSI design process and fabrication techniques of VLSI IC.

CO2: Describe the electrical properties and behavior of MOS Transistors.

CO3: Design different digital logic circuits using NMOS and CMOS.

CO4: Realize VLSI subsystem design using arithmetic building blocks.

CO5: Discuss the essential for low power, sources of power dissipation, and various power analysis and estimation techniques in VLSI

CO-PO MAPPING

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

Artificial Intelligence and Machine Learning

Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BELC22 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study uninformed and heuristic search techniques and the techniques for reasoning under uncertainty.

CLO2: To discuss the machine learning techniques (supervised, unsupervised, and ensemble techniques) and the basics of neural networks.

UNIT - I Problem Solving 9

Introduction to AI, AI Applications, Problem-solving Agents, Search algorithms: Uninformed Search Strategies – Heuristic Search Strategies – Local Search and Optimization Problems – Adversarial search, Constraint Satisfaction Problems (CSP).

UNIT - II Probabilistic Reasoning 9

Acting under Uncertainty, Bayesian Inference, Naïve Bayes models, Probabilistic Reasoning, Bayesian Networks (BN) – Exact Inference in BN – Approximate Inference in BN, Causal Networks.

UNIT - III Supervised Learning 9

Introduction to Machine Learning - Linear Regression Models: Least Squares, Single & Multiple Variables, Bayesian Linear Regression, Gradient Descent - Linear Classification Models: Discriminant Function, Probabilistic Discriminative Model, Logistic Regression, Support Vector Machine (SVM), Decision Tree, Random forests - Implementing basic learning algorithms using TensorFlow.

UNIT - IV Ensemble Techniques and Unsupervised Learning 9

Combining Multiple Learners: Model Combination Schemes, Voting - Ensemble Learning: Bagging, Boosting, Stacking - Unsupervised Learning: K-Means - Instance-Based Learning: K- Nearest N.

UNIT - V Neural Networks 9

Perceptron - Multilayer Perceptron, Activation Functions, Network Training – Gradient Descent Optimization – Stochastic Gradient Descent, Error Backpropagation, ReLU - Hyperparameter Tuning, Batch Normalization, Regularization, Dropout.

Total Hours: **45**

References:

1 Stuart Russell and Peter Norvig. (2021). *Artificial Intelligence – A Modern Approach*. Pearson Education. 4th Edition.

2 Ethem Alpaydin. (2020). *Introduction to Machine Learning*. MIT Press. 4th Edition.

3 Dan W. Patterson. (2007). *Introduction to Artificial Intelligence and Expert Systems*. Pearson Education.

4 Kevin Night, Elaine Rich & Nair B. (2008). *Artificial Intelligence*. McGraw Hill.

5 Patrick H. Winston. (2006). *Artificial Intelligence*. Pearson Education. 3rd Edition.

Course Outcomes:

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

CO1: Use appropriate search algorithms for problem-solving.

CO2: Apply the techniques for reasoning under uncertainty.

CO3: Explain the architecture and applications of supervised learning models.

CO4: Enumerate the applications of ensemble and unsupervised learning models.

CO5: Discuss the basic deep learning neural network models.

CO - PO MAPPING

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

Mobile Communication and Networks

Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BELC23 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the fundamentals of in mobile communication systems.
CLO2: To evaluate the diverse networking techniques for mobile communication.

UNIT - I Introduction to Cellular Mobile Radio Systems 9

Limitations of Conventional Mobile Telephone Systems. Basic Cellular Mobile System, First, Second, Third and Fourth Generation Cellular Wireless Systems. Uniqueness of Mobile Radio Environment-Coherence Bandwidth, Doppler Spread and Coherence Time. Concept of Frequency Reuse, Co-Channel Interference, Co-Channel Interference Reduction Factor, System Capacity Improving Coverage and Capacity in Cellular Systems- Cell Splitting, Sectoring, Microcell Zone Concept.

UNIT - II Co-Channel and Non Co-Channel Interference 9

Measurement of Real Time Co-Channel Interference, Design of Antenna System, Antenna Parameters and their effects, diversity techniques-space diversity, polarization diversity, frequency diversity, time diversity. Adjacent Channel Interference, Near end far end interference, cross talk, effects on coverage and interference by power decrease, antenna height decrease, effects of cell site components.

UNIT - III Cell Coverage for Signal and Traffic 9

Signal Reflections in flat and Hilly Terrain, effects of Human Made Structures, phase difference between direct and reflected paths, constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long-distance propagation, path loss from a point to point prediction model in different conditions, merits of lee model.

UNIT - IV Handoffs and Dropped Calls 9

Handoff Initiation, types of Handoff, Delaying Handoff, advantages of Handoff, Power Difference Handoff, Forced Handoff, Mobile Assisted and Soft Handoff, Intersystem handoff, Introduction to Dropped Call Rates and their Evaluation.

UNIT - V Ad Hoc Wireless Networks **9**

Introduction, Cellular and Ad Hoc wireless Networks, Applications and Ad Hoc Wireless Networks, Issues in Ad Hoc Wireless Networks, Ad Hoc Wireless Internet, MAC Protocols for Ad Hoc Wireless, Introduction, issues in designing AMAC Protocol for Ad Hoc wireless Networks, Design Goals of AMAC protocol for Ad Hoc Wireless Networks, Classification of MAC Protocols.

Total Hours: **45**

References:

1 W.C.Y. Lee. (2015). *Mobile Cellular Telecommunications*. Mc Graw Hill. 2nd Edition.
2 Theodore. S. Rapport. (2002). *Wireless Communications*. Pearson Education. 2nd Edition.
3 C. Sivaram Murthy and B.S. Manoj. (2004). *Ad Hoc Wireless Networks: Architectures and Protocols*. Pearson Education.
4 Simon Haykin, Michael Moher.(2005).*Modern Wireless Communications*. Pearson Education.
5 Vijay Garg. (2007). *Wireless Communications and Networking*. Elsevier Publications.
6 Andrea Goldsmith. (2005). *Wireless Communications*. Cambridge University Press.

Course Outcomes:

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

CO1: Explain the evolution of mobile communication systems.
CO2: Apply and analyze co-channel and non-co-channel interferences.
CO3: Examine and overcome the effects of different fading in diverse environments.
CO4: Examine and analyze the cell coverage for signal and traffic and handoff calls.
CO5: Analyze and apply the diverse networking techniques of mobile communication.

CO - PO MAPPING

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

Microwave and Optical Communication

Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BELC24 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To design and analyze the performance of microwave devices.
CLO2: To analyze the propagation of optical signal in optical communication systems.

UNIT - I Microwave Parameters 9

Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters,High Frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network, Transmission matrix, RF behaviour of Resistors, Capacitors and Inductors.

UNIT - II Passive and Active Microwave Components 9

Waveguide Tee junctions and Magic Tee - Directional couplers - Isolators and Circulators, Gunn diode oscillator, Varactor diode, tunnel diode and PIN diode. Microwave Tubes: Reflex klystron - Cylindrical magnetron oscillator.

UNIT - III Microstrip Circuits and Microwave Measurements 9

Microstrip transmission line, Microstrip Wilkinson power divider, Microstrip low pass filter, Microstrip branch-line coupler, VSWR meter, Spectrum Analyzer, Network Analyzer, frequency measurement - impedance measurements.
Case study- RADAR and Satellite Communication, Industrial Heating, MIC, MMIC. Microwave Hazards

UNIT - IV Introduction to Fiber Optics 9

Block diagram of optical communication system - Advantages - Ray theory transmission - Total internal reflection - Acceptance angle - Numerical Aperture - skew rays and meridional rays - cylindrical fibers- SM fibers.

UNIT - V Optical Sources and Detector 9

Light dependent resistor-Photodiode-Photo transistor - Light emitting diode-LASER diode-PIN photo detectors-Avalanche photo diode-Fiber attenuation Measurements-OTDR-Dispersion measurements.

Total Hours: **45**

References:

1 LiaoY.S. (2006). *Microwave Devices and Circuits*. Prentice Hall of India. 2nd Edition.
2 Annapurna Das. (2004). *Microwave Engineering*. Tata McGraw Hill.
3 David M.Pozar. (2015). *Microwave Engineering*. John Wiley and Sons Inc.
4 R.P. Khare. (2007). *Fiber Optics and Optoelectronics.* Oxford University Press.
5 John M. Senior. (2009). *Optical Fiber Communication*. Pearson Education.3rd Edition.
6 Gerd Keiser. (2008). *Optical Fiber Communications*. Tata McGraw Hill.4th Edition.
7 Govind P. Agrawal. (2007). *Fiber Optic communication*. John Wiley & sons. 3rd Edition.

Course Outcomes:

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

CO1: Explain various microwave parameters.
CO2: Design and test microwave systems.
CO3: Test and measure the behavior of microwave devices.
CO4: Analyze the propagation of optical rays in fiber optical waveguides.
CO5: Evaluate the propagation of optical waves in optical communication systems.

CO - PO MAPPING

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

VLSI Design Laboratory

Semester: VI **Hours of Instruction/Week: 3P**

Course Code: 24BELC25 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To design and simulate CMOS inverter, logic gates, combinational and sequential logic circuits.

CLO2: To design, realize and test arithmetic logic circuits and memories.

List of Experiments

1. Study the characteristics of NMOS and PMOS Transistors.
2. Design and Simulation of NMOS inverter, CMOS inverter Logic design using pass transistors, transmission gates and static CMOS logic.
3. Design and Simulation of simple combinational circuits (encoder, multiplexer, code converters.)
4. Design and Simulation of ALU subsystem –Adders, Multipliers.
5. Design and Simulation of sequential circuits (counters, shift registers).
6. Design and Simulation of memory cell.

Total Hours: **45**

Course Outcomes:

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

CO1: Use modern design tools like Xilinx to simulate CMOS inverter and logic gates using MOS Transistor.

CO2: Design and simulate combinational and sequential logic circuits using MOS transistors.

CO3: Conceive and design digital sub systems including ALU and memory.

CO - PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	2	-	-	-	2	2	1	1
CO2	2	2	1	1	2	-	-	-	2	2	1	1
CO3	2	2	2	1	2	-	-	-	2	2	1	1

Microwave and Optical Communication Laboratory

Semester: VI **Hours of Instruction/week: 3P**

Course Code: 24BELC26 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To test and measure the parameters of microwave devices and optical fibers.
CLO2: To establish data transmission through optical fibers.

List of Experiments:

Microwave Engineering:

1. Study of mode characteristics of Reflex Klystron.
2. Study the characteristics of Gunn Diode Oscillator
3. Study and demonstrate characteristics of directional coupler, E/H Tee and, Magic Tee.
4. Determine the radiation pattern of Horn Antenna
5. Frequency and wavelength measurement at microwave frequencies.
6. Testing and measurement of C-band Microstrip line and Microstrip low pass filter.
7. Testing and measurement of C-band Microstrip branch-line coupler.
8. Testing and measurement of C-band Microstrip power divider with and without chip resister.

Optical Communication:

1. Design and demonstration of analog and digital link using fiber optic cable.
2. Measurement of bending loss in various optical fibers.
3. Data transmission through Fiber Optic Link.
4. Measurement of numerical aperture and propagation loss in fibers.
5. Testing of Time Division Multiplexing.

Total Hours: **45**

Course Outcomes:

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

CO1: Evaluate and verify the specifications of microwave devices.
CO2: Measure and test the characteristics of microwave sources.
CO3: Demonstrate data transmission in optical link and the characteristics of optical fibers.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	-	-	-	1	1	1	2
CO2	2	2	2	2	2	-	-	-	1	1	1	2
CO3	2	2	2	2	2	-	-	-	1	1	1	2

Advanced Digital Signal Processing

PE1 - Semester: VI **Hours of Instruction/Week: 3T**

Course Code: 24BELE05 **No. of credits:3**

Pre–Requisite: Digital Signal Processing.

Course Learning Objectives(CLOs):

CLO1: To understand and learn the concepts of multirate signal processing, power spectrum estimation, adaptive filters.

CLO2: To analyze optimum filters and wavelet transforms for the real time image processing applications.

UNIT-I Multirate Signal Processing **9**

Down sampling – Up sampling - Noble identities – cascading sampling rate convertors - Decimation with transversal filters – interpolation with transversal filters – decimation with poly phase filters – interpolation with poly phase filters – decimation and interpolation with rational sampling factors - multistage implementation of sampling rate convertors.

UNIT-II Power Spectrum Estimation **9**

Introduction to random process - Nonparametric methods - Periodogram – Modified Periodogram - Bartlett, Welch & Blackman Tukey methods - Performance comparison - Parametric methods - Auto Regressive spectrum estimation - Relationship between autocorrelation and model parameters – Moving Average and Auto Regressive Moving Average spectrum estimation.

UNIT-III Optimum Filters **9**

Wiener filters - FIR Wiener filter - discrete Wiener Hopf equation, Applications - filtering, linear prediction. IIR Wiener filter - causal and non-causal filters. Recursive estimators - discrete Kalman filter.

UNIT-IV Adaptive Filters **9**

Principles and properties of adaptive filters - FIR adaptive filters. Adaptive algorithms - steepest descent algorithm, the LMS algorithm - convergence. Applications of adaptive filtering - noise cancellation, channel equalization.

UNIT-V Wavelet Transforms **9**

Need for Time Frequency Analysis–Short time Fourier transform-short comings of STFT-Need for Wavelets - Continuous time Wavelet Transform – Multi Resolution Analysis Haar and Daubechies wavelet functions –Introduction to Discrete Wavelet Transform.

Total Hours: **45**

References:

1 Fliege N J.*(*2010). *Multirate Digital Signal Processing.* John Wiley and sons.

2 Monson H.Hayes.(2011).*Statistical Digital Signal Processing and Modeling.* John Wiley and
Sons,Inc.,Singapore.

3 Widrow B., &Stearns .SD. (2011).*Adaptive Signal Processing.* Prentice Hall inc.

4 K.P.Soman., K.I.Ramachandran & N.G.Resmi. (2010). Insight into Wavelets from Theoryto Practice. PHI Learning Private limited.3rd Edition.

5 Ifeachor EC.,&JervisB.W.(2020).*Digital Signal Processing: A Practical Approach.* Prentice Hall.

6 Jaideva C Goswami.,& Andrew KChan.,(2013).*Fundamentals of Wavelets–Theory, Algorithms and Applications.* John Wiley and Sons, Inc., Singapore.

Course Outcomes:

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

CO1 : Understand the fundamentals of multirate signal processing.

CO2 : Explain the non parametric and parametric methods for power spectrum estimation.

CO3 : Analyze and design multirate filters techniques using various algorithms.

CO4: Analyze and design adaptive filtering techniques using various algorithms.

CO5: Analyze the wavelet transforms to implement real time image processing applications.

CO-PO MAPPING

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

Advanced Digital Communication

PE1 - Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE06 **No. of credits:3**

Pre–Requisite: Information coding theory, Digital Communication

Course Learning Objectives (CLOs):

CLO1: Explain the block coded and convolutional coded digital communication.
CLO2: Analyse the multi user and multi carrier communication.

UNIT-I Coherent and Non-Coherent Communication 9

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Non-coherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier Synchronization-Bit synchronization.

UNIT-II Equalization Techniques 9

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals-Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT-III Block Coded Digital Communication 9

Architecture and performance – Binary block codes; Orthogonal; Bi-orthogonal; Trans orthogonal – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

UNIT-IV Convolutional Coded Digital Communication 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT-V Multicarrier and Multiuser Communications 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

Total Hours:**45**

References:

1 Bernard Sklar.(2001).*Digital Communications*. Pearson Education. 2nd Edition.

2 JohnG. Proakis.(2008).*Digital Communication.*McGrawHillPublication.5thEdition.

3 M.K.Simon,S.M.Hinedi and W.C.Lindsey.(1995).*Digital communication techniques; Signal Design and Detection.* Prentice Hall of India.

4 Richard Van Nee & Ramjee Prasad.(2001).*OFDM for Multimedia Communications.* Artech House Publication.

5 StephenG.Wilson.(2003).*Digital Modulation and Coding*.PearsonEducation.1st Indian Reprint.

6 Simon Haykin. (1998).*Digital communications.* John Wiley and sons.

7 TheodoreS.Rappaport.(2010).*WirelessCommunications*.PearsonVEducation.2ndEdition.

Course Outcomes:

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

CO1: Develop the ability to understand the concepts of signal space analysis for coherent and Non-coherent receivers.

CO2: Predict the behavior of different Equalization techniques.

CO3: Possess knowledge on different block codes.

CO4: Interpret the need of convolutional codes.

CO5: Comprehend the generation of OFDM signals and the techniques of multi user detection.

CO-PO MAPPING

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

Smart Antennas

PE1 - Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE07 **No.ofcredits:3**

Pre–Requisite: Microwave and optical communication, Antennas and Wave Propagation.

Course Learning Objectives (CLOs):

CLO1: To examine the performance of smart antennas and their radiation characteristics.

CLO2: To design and test Micro strip antennas, array antennas for smart antenna applications.

UNIT-I Introduction to Smart Antennas 9

Need for smart antennas, standards for smart antennas, types of smart antennas, features and benefits ,architecture, advantages and disadvantages of smart antennas, introduction to orthogonal signals, signal propagation: multipath and co-channel Interference. Concept and benefits of smart antennas, fixed weight beam forming basics. Adaptive beam forming. Switched beam systems.

UNIT-II Fixed Beam Smart Antenna Systems 9

Introduction, Conventional Sectorization, Limitations of Conventional Sectorization, Antenna Arrays Fundamentals, Broadside and End-Fire Arrays , Impact of Number of Elements, Impact of Element Spacing , Beam width, Beam forming, The Butler Matrix, Spatial Filtering with Beam formers, Switched Beam Systems, Multiple Fixed Beam Systems, Adaptive Cell Sectorization in CDMA Systems.

UNIT-III Microstrip Antennas 9

Basic characteristics of micro strip antennas, feeding methods, methods of analysis, Design of rectangular and circular patch antennas.

UNIT-IV Adaptive Array Systems 9

Uplink Processing, Diversity Techniques, Angle Diversity, Maximum Ratio Combining , Adaptive Beam forming , Beam Steering, Maximum Signal-to-Interference and Noise Ratio , Minimum Mean Square Error,, Downlink Processing, Transmit Diversity Concepts , Downlink Beam forming, Spatial Signature-Based Beam forming, DOA-Based Beam forming, Maximum SNR.

UNIT-V Smart Antennas System Aspects 9

Introduction, Third Generation Air Interfaces and Protocol Stacks, Physical Layer, Mobile Call States, Mobility Procedures to Support High-Speed Data Transfer, Procedures to Re-establish High- Speed Data Transfer, Packet Data Services, Pilot Channels, Channels Applicable for Downlink Beamforming,OverviewofMajorRadioNetworkAlgorithms,SystemImpactofAdvancedSpatial Techniques, Beam Steering/Adaptive Beam forming

Total Hours:**45**

References:

1. C.A.Balanis.(2005).*Antenna Theory and Design*. John Wiley&Sons.3rdEdition.
2. F.B.Gross.(2005).*Smart Antennas for Wireless Communications*. McGraw-Hill.
3. J.D.Krausand Ronald J Marhefka.(2003).*Antennas For all Applications*. Tata Mc Graw-Hill. 3rdEdition.
4. R.E.Collin.(1985).*Antennas and Radio Wave Propagation*. McGraw-Hill.
5. R.S.Elliot.(2003).*Antenna Theory and Design*. Wiley-IEEE Press.
6. Ahmed AI Zooghby. (2005).*Smart Antenna Engineering*. Artech House Inc.
7. F.B.Gross.(2005).*Smart Antennas for Wireless Communications*. McGraw-Hill.

Course Outcomes:

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

CO1: Explain the importance of smart antennas in future communication systems.

CO2: Design fixed beam smart antennas.

CO3: Design and implementation of microstrip smart antennas.

CO4: Design and examine adaptive array antennas.

CO5: Evaluate the system aspects of smart antennas.

CO-PO MAPPING

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

Satellite Communication

PE1- Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE08 **No. of credits:3**

Pre–Requisite: Microwave and optical communication, Antenna and Wave Propagation.

Course Learning Objectives (CLOs):

CLO1: To understand the basics of satellite orbits, segment, earth segment and link design.
CLO2: To analyze the various methods of satellite access techniques, networks and applications.

UNIT-I Satellite Orbits **9**

Kepler's Laws, Newton's Law, Orbital Parameters, Orbital Perturbations, Station Keeping, Geo Stationary and Non Geo-Stationary Orbits – Look Angle Determination - Limits of Visibility – Eclipse - Sub Satellite Point – Sun Transit Outage - Launching Procedures - Launch Vehicles and Propulsion.

UNIT-II Space Segment **9**

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 **9**

Basic Link Analysis, Interference Analysis, Rain Induced Attenuation and Interference, Ionospheric Characteristics, Link Design with and without Frequency Reuse.

UNIT-IV Satellite Access and Coding Methods **9**

Modulation and Multiplexing: Voice, Data, Video, and Analog – Digital Transmission System, Digital Video Broadcast, Multiple Access Techniques: FDMA, TDMA, CDMA, DAMA Assignment Methods, Compression – Encryption, Coding Schemes.

UNIT-V Satellite Applications **9**

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).

Total Hours:**45**

References:

1. Dennis Roddy. (2006).*Satellite Communication*.McGrawHill.4thEdition.
2. Timothy, Pratt Charles W.Bostain, Jeremy E. Allnutt. (2002). *Satellite Communication*. Wiley Publications. 2nd Edition.
3. Wilbur L.Pritchard,Hendri G.Suyderhoud,Robert A.Nelson.(2007).*Satellite Communication Systems Engineering*. Prentice Hall.
4. Bruce R.Elbert.(1997). *The Satellite Communication Applications*. Artech House.
5. TriT.Ha.(1990).*Digital Satellite Communication*. McGraw Hill Inc.2ndEdition.
6. M.Richharia.(2003). *Satellite Communication Systems-Design Principles*. Macmillan.

Course Outcomes:

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

CO1: Analyze the satellite orbits.

CO2: Evaluate the earth segment and space segment.

CO3: Apply the design concepts to create the satellite ink.

CO4: Applyandidentifytherequiredmultipleaccesstechniquesforsatelliteapplications.

CO5: Design satellite for diverse applications.

CO-PO MAPPING

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

Printed and Wearable Electronics

PE2 - Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE25 **No. of credits:3**

Pre–Requisite: Basic Electronics.

Course Learning Objectives (CLOs):

CLO1: To understand the need for wearable devices and its application on various sectors such as healthcare, sports, environment monitoring and navigation.

CLO2: Critically assess the usability and societal impact of various types of wearable devices in different contexts and industries.

UNIT-I Introduction to Wearable Devices and Sensors 9

Emergence of wearable computing and wearable electronics -Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing - Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety - Wearable Inertial Sensors-Accelerometers, Gyroscopic sensors and Magnetic sensors – Wearable Sensors-In- Shoe Force and Pressure Measurement - Applications: Fall Risk Assessment, Fall Detection , Gait Analysis, Human Kinetics, Cardiac Activity.

UNIT-II Wearable Devices for Healthcare 9

Electrode- geometry, material -Fabrication of Inter Digitated (IDE) electrodes, choice of substrate, sensing film - Wearable ECG devices: Basics of ECG and its design, Electrodes and the Electrode Skin Interface - Wearable EEG devices: Principle and origin of EEG, Basic Measurement set- up, electrodes and instrumentation - Wearable EMG devices: EMG Signals, EMG Measurement, Wearable surface electrodes - Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuff less Blood Pressure Monitor - Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring - Detection principles – thermistor, infrared radiation - Modality of measurement.

UNIT-III Wearable Biochemical and Gas Sensors 9

Wearable Biochemical Sensors: Parameters of interest –Textile based –Micro needle based - Types: Non-invasive Glucose Monitoring Devices - Pulse oximeter – Portable Pulse Oximeters - Wearable pulse oximeter - Wearable capnometer for monitoring of expired carbon dioxide - Wearable gas sensors: Metal Oxide (MOS) type, electrochemical type - Detection of atmospheric pollutants.

UNIT-IV Wearable Cameras and Microphones for Navigation 9

Cameras in wearable devices - Applications in safety and security -Navigation - Automatic digital diary-Camerasinsmart-watches-UseofWearableMicrophones-MEMSmicrophones-

Bioacoustics - Wearable Assistive Devices for the Blind - Hearing and Touch sensation - Assistive Devices for Fingers and Hands – Assistive Devices for wrist, vests and belts, head-mounted devices.

UNIT-V Other Wearable Devices 9

Wearable devices with Global Positioning System (GPS) integration for tracking and navigation - Wearable Optical Sensors - UV exposure indicators - Speech recognition using lasers - Photo Plethysmography (PPG) - 3D imaging and motion capture.

Total Hours:**45**

References:

1 Toshiyo Tamura and Wenxi Chen.(2018).*Seamless Healthcare Monitoring*. Springer.

2 Edward Sazonov and Michael R.Neuman.(2014).*Wearable Sensors-Fundamentals, Implementation and Applications*. Elsevier Inc.

3 AiméLay-Ekuakille and Subhas Chandra Mukhopadhyay.(2010).*Wearable and Autonomous Biomedical Devices and Systems for Smart Environment* .Springer.

4 Subhas Chandra Mukhopadhyay.(2015).*Wearable Electronics Sensors-For Safe and Healthy Living* .Springer.

5 Shantanu Bhattacharya,A K Agarwal,Nripen Chanda,Ashok Pandey and AshisKumar Sen. (2018). *Environmental, Chemical and Medical Sensors*. Springer Nature Singapore Pvt. Ltd.

6 XiaojunGuo.(2023).*Printed and Flexible Electronics: Fabrication, Materials, and Applications*. Springer

7 SimonM.Sze.(2024).*Printed Electronics:Materials, Technologies and Applications*. Springer.

Course Outcomes:

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

CO1: Explain the components and functionalities of wearable devices including sensors, data Processing units and communication modules.

CO2: Analyze the design and development of wearable bio-electrode for developing monitoring devices for health care applications.

CO3: Discuss and analyze the usage of various biochemical and gas sensors for environment monitoring.

CO4: Identify the use of various wearable locomotive tools for navigation and other real time applications.

CO5: Explore a variety of emerging wearable devices beyond health care and navigation such as smart textiles, augmented reality glasses and speech recognition devices.

CO-PO MAPPING

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

Embedded OS and RTOS

PE2 - Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE26 **No. of credits:3**

Pre–Requisite: C, C++ and Operating System.

Course Learning Objectives (CLOs):

CLO1: To understand real-time operating system(RTOS)and the types of RTOS.

CLO2: To analyse the features of some of the popular Real Time OS: POSIX, Vx Works, RT-Linux.

UNIT-I Embedded OS(Linux)Internals 9

Linux internals: Process Management, File Management, Memory Management, I/O Management. Overview of POSIX APIs, Threads – Creation, Cancellation, POSIX Threads Inter Process Communication – Semaphore, Pipes, FIFO, Shared Memory, Kernel: Structure, Kernel Module Programming, Schedulers and types of scheduling. Interfacing: Serial, Parallel Interrupt Handling, Linux Device Drivers: Character, USB, Block & Network.

UNIT-II Open source RTOS 9

Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Basic architecture of an RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Interrupt management in RTOS environment, Memory management, File systems, I/O Systems, Advantage and disadvantage of RTOS.

UNIT-III RTOS Standards 9

POSIX standards, RTOS Issues–Selecting a Real Time Operating System, RTOS comparative study. Converting a normal Linux kernel to real time kernel, Xenomai basics. Overview of Open source RTOS for Embedded systems (Free RTOS/ Chibios-RT) and application development.

UNIT-IV VxWorks/Free RTOS 9

VxWorks/ Free RTOS Scheduling and Task Management – Real-time scheduling, Task Creation, Inter task Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts, I/O Systems–GeneralArchitecture,DeviceDriverStudies,DriverModuleexplanation,Implementation of Device Driver for a peripheral.

UNIT-V Case Study 9

Cross compilers, debugging Techniques, Creation of binaries &porting stages for Embedded Development board(Beagle Bone Black, Rpi or similar),Porting an Embedded OS/RTOS to a target board ().Testing a real time application on the board.

Total Hours:**45**

References:

1 Venkateswaran Sreekrishnan.(2008).*Essential Linux Device Drivers*. Prentice Hal.

2 QingLi.(2003).*Real Time Concepts for Embedded Systems*. CMP Books, Elsevier.

3 Prasad KVK.(2007).*Embedded / Real Time Systems Concepts, Design and Programming Black Book*. New Delhi Dream tech

4 JaneLiu.(2000).*Real-time Systems*. Pearson Education Inc .and Dorling Kindersley.

5 Simon.,& David E.(2002).*Embedded Software Primer*. Pearson Education.

Course Outcomes:

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

CO1: Understand Linux operating system, device drivers and open source RTOS and their usage.

CO2: Classify and exemplify scheduling algorithms.

CO3: Build real-time embedded systems using free RTOS and Vx Works RTOS.

CO4: To understand the concepts of VxWorks /Free RTOS.

CO5: Discuss about various Embedded OS/RTOS applications.

CO-PO MAPPING

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

Wireless Sensor Networks

PE2 - Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE27 **No.ofcredits:3**

Pre–Requisite: Computer Networks.

Course Learning Objectives (CLOs):

CLO1: To learn about overview of wireless sensor networks, architectures and its Protocols
CLO2: To understand the concepts of infrastructure establishment, network platforms and tools.

UNIT-I Overview of Wireless Sensor Networks **9**

Challenges for wireless sensor networks, Comparison of sensor network with adhoc network. Sensor Localization, Clock synchronization, Power management, Special WSNs, WSN Applications.

UNIT-II Architecture **9**

Single-Node Architecture-Hardware Components, Energy Consumption of Sensor Nodes Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT-III Networking Sensors **9**

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

UNIT-IV Infrastructure Establishment **9**

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT-V Sensor Network Platforms and Tools **9**

Sensor Node Hardware –Berkeley Motes, Programming Challenges, Node level software platforms, Node-level Simulators, State-centric programming

Total Hours:**45**

References:

1 Holger Karl &Andreas Willig.(2005).*Protocols and Architectures for Wireless Sensor Networks*. John Wiley.
2 FengZhao.,&Leonidas J.Guibas.(2007).*Wireless Sensor Networks-an Information Processing Approach*. Elsevier.
3 Kazem Sohraby.,Daniel Minoli.,&Taieb Znati.(2007).*Wireless Sensor Networks-Technology, Protocols And Applications*. John Wiley.
4 Anna Hac.(2003).*Wireless Sensor Network Designs*. John Wiley.
5 Carlos DeMorais Cordeiro.,& Dharma Prakash Agarwal.(2006).*Ad Hoc &Sensor Networks: Theory and Applications*. World Scientific Publishing Company.

Course Outcomes:

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

CO1: Illustrate the challenges and applications of wireless sensor networks.
CO2: Explain the network architecture of WSN in various aspects.
CO3: Design MAC and routing protocols for wireless sensor networks.
CO4: Illustrate the concept of infrastructure establishment of WSN.
CO5: Discuss about various sensor network platforms and tools.

CO-PO MAPPING

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

Deep Learning

PE2 - Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE28 **No. of credits:3**

Pre–Requisite: Artificial Intelligent and Machine Learning, Calculus and Linear Algebra.

Course Learning Objectives (CLOs):

CLO1: To understand the need and principles of deep neural networks such as Convolutional Neural Networks and Recurrent Neural Networks.
CLO2: To comprehend advanced deep learning models and learn the evaluation metrics for deep learning models.

UNIT-I Deep Networks Basics **9**

Linear Algebra: Scalars, Vectors, Matrices and Tensors - Probability Distributions - Gradient-based Optimization-Machine Learning Basics: Capacity, Overfitting and Underfitting, Hyperparameter and validation sets, Estimators, Bias and variance - Stochastic Gradient Descent - Deep Networks: Deep feed-forward networks, Regularization, Optimization.

UNIT-II Convolutional Neural Networks (CNNs) **9**

Introduction to CNN, Building a CNN: Input Layers – Convolution Layers- Pooling Layers- Dense Layers, Back propagation through the Convolutional Layer, Filters and Feature Maps, CNN Learning: Nonlinearity Functions – Loss Functions – Regularization – Optimizers – Gradient Computation.

UNIT-III Recurrent Neural Networks (RNNs) **9**

Unfolding Graphs, RNN Design Patterns: Acceptor –Encoder –Transducer, Gradient Computation, Bidirectional RNN, Deep Recurrent Networks, Long Term Dependencies, Leaky Units: Skip connections and dropouts, Gated Architecture: LSTM.

UNIT-IV Model Evaluation **9**

Performance metrics, Baseline Models, Hyper parameters: Manual Hyper parameter–Automatic Hyper parameter, Grid search, Random search, Debugging strategies.

UNIT-V Auto encoders and Generative Models **9**

Auto encoders: Under complete auto encoders – Regularized auto encoders – Stochastic encoders and decoders, Learning with Auto encoders, Deep Generative Models, Variational Auto encoders, Generative adversarial networks.

Total Hours:**45**

References:

1 Ian Good fellow, Yoshua Bengio &Aaron Courville. (2016).*Deep Learning*. MIT Press.

2 Josh Patterson & Adam Gibson.(2017).*Deep Learning: A Practitioner's Approach*. O'Reilly Media.

3 Salman Khan, Hossein Rahmani, Syed Afaq AliShah & Mohammed Bennamoun.(2018). *A Guide to Convolutional Neural Networks for Computer Vision*. Synthesis Lectures on Computer Vision, Morgan & Claypool Publishers.

4 Charu C. Aggarwal.(2018).*Neural Networks and Deep Learning: A Textbook*. Springer International Publishing.

5 Andrew Glassner.(2021).*Deep Learning: A Visual Approach*. No Starch Press.

Course Outcomes:

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

CO1: Discuss the basics of deep neural networks.

CO2: Elaborate on the applications of Convolution Neural Networks.

CO3: Explain the architecture and applications of Recurrent Neural Networks.

CO4: Summarize various model evaluations for analyzing the deep neural networks.

CO5: Apply auto encoders and generative models for suitable applications.

CO-PO MAPPING

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

School of Engineering

Essence of Indian Knowledge Tradition
(Non – Credit Mandatory Course)

(Applicable for the B.E students admitted from the academic year 2024-2025 & onwards)

Semester IV **Hours of Instruction/week: 3T**
Course Code: 24BEMC04

Course Learning Objectives (CLOs):

CLO1: Gain knowledge in Indian Philosophical Foundations.
CLO2: Know Indian Languages and Literature and the fine arts in India & their Philosophy.
CLO3: Explore the Science and Scientists of Medieval and Modern India.

UNIT - I Introduction to Indian Philosophy **9**

Basics of Indian Philosophy, culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian culture, Ancient Indian, Medieval India, Modern India.

UNIT - II Indian Philosophy & Literature **9**

Vedas Upanishads, schools of Vedanta, and other religion Philosophical Literature. Philosophical Ideas the role of Sanskrit, significance of scriptures to current society, Indian Philosophies, literature of south India. Indian languages and Literature-II: Northern Indian languages & Philosophical & cultural & literature.

UNIT- III Religion and Philosophy **9**

Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only).

UNIT- IV Indian Fine Arts & Its Philosophy (Art, Technology & Engineering) **9**

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in Indian, development of science in ancient, medieval and modern Indian.

UNIT - V Education System in India **9**

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Total Hours: **45**

References:

1. Kapoor, K. (2005). *Text and Interpretation: The India Tradition*.
2. *Science in Samskrit*. (2007). Samskrita Bharti Publisher.
3. NCERT – "*Position paper on Arts, Music, Dance and Theatre*".
4. Narain, S. (1993). *Examinations in Ancient India*.
5. Prakash, S. (1989). *Founders of Sciences in Ancient India*.
6. Mysore Hiriyanna. (2008). *The essentials of Indian philosophy*. Motilal Banarsidass Publishers.
7. Satischandra Chatterjee, & Dhirendra Mohan Datta. (2016). *An introduction to Indian philosophy*. Motilal Banarsidass Publishers Private Limited.

Course Outcomes:

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

CO1: Understand philosophy of Indian culture
CO2: Distinguish the Indian languages and literature among difference traditions
CO3: Learn the philosophy of ancient, medieval and modern India.
CO4: Acquire the information about the fine arts in India.
CO5: Know the contribution of scientists of different eras.

CO - PO MAPPING

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

Principles of Management and Economics

Semester: VII **Hours of Instruction/Week: 3T**
Corse code: 24BEHS09 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study and apply the principles of management and Economics in industrial and business organizations with the code of Ethics.

CLO2: The aim is to inculcate the ability to apply multifunctional approach to organizational objective.

UNIT - I Introduction to management skills **9**

Principles of management - Evolution of management - Development of managerial skills - Capital budgeting - Depreciation Analysis - Break even analysis.

UNIT - II Human Resource Management **9**

Industrial and business organization - Resource mobilization - Small scale industries, medium scale industries and Large-scale industries - Human resource management, Importance, Objective functions - Job analysis and recruitment, selection and placement, Training development.

UNIT - III Production Planning and Quality Control **9**

Plant design location - Production planning and control - Network analysis, PERT, CPM and cost analysis - Marketing functions - Sales promotion and advertisement - Principles of accounting - Statistical Quality control, Objectives and methods, Techniques of SQC - Control charts, procedure of sampling inspection.

UNIT - IV Principles of Economics **9**

Economic reasoning - Circular Flow in an economy - Law of supply and demand - Economic efficiency - Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Private and Social cost, Opportunity cost - Functions of Money and Commercial Banking - Inflation and deflation: concepts and regulatory measures - Economic Policy Reforms in India since 1991: Industrial policy, Foreign Trade Policy, Monetary and fiscal policy, Impact on industry

UNIT - V Project management Software **9**

Software tools in modern Project Management scenario. Demonstration and case study using soft wares like ProWork, JIRA, Ace Project, Workflow Max, ProCore.

Total Hours: 45

References:

1 O.P.Khanna.(2013).*Industrial Engineering and Management.* Dhanpat Rai Publications.

2 R. Panneer Selvam.(2013). *Engineering economics.* Prentice Hall of India. New Delhi.

3 Shukla, M.C. (2010). *Business Organization and Management.* S. Chand & Co. Ltd.

4 Elwood S Buffa. (2009). *Modern Production /Operation Management.* John Wiley and Sons. 8th Edition.

5 S. Kathiresan and V. Radha. (2008). *Business Organization.* Bhavani Publications. 4th Edition.

Course Outcomes:

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

CO1: Compile the history of organizational behaviour, dynamics of marketing in business and theories of moral development.

CO2: Analyze and Apply the cost concepts using PERT, CPM and SQC techniques.

CO3: Apply the principles of Management, Economics and quality control in an organization.

CO4: Apply project management software tools in modern Project Management scenario.

CO5: Evaluate the different market structures and equilibrium for different industries.

CO - PO MAPPING

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

Digital Image Processing and Computer Vision

Semester: VII **Hours of Instruction/week: 3T**

Course Code: 24BELC28 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study the basic principles of Digital Image Processing techniques.
CLO2: To lay the theoretical foundation of image processing techniques for the design of efficient algorithms for real-world applications.

UNIT - I Digital Image Fundamentals **9**

Steps in Digital Image Processing, Components, Elements of Visual Perception - Image Sampling and Quantization, Some basic relationships like Neighbors, Connectivity, and Distance Measures between pixels, Two-dimensional mathematical preliminaries, 2D transforms – DFT.

UNIT - II Image Enhancement **9**

Spatial Domain: Gray level transformations - Histogram Processing - Basics of Spatial Filtering: Smoothing and Sharpening Spatial Filtering. Frequency Domain: Introduction to Fourier Transform - Smoothing and Sharpening Frequency Domain Filters: Ideal, Butterworth, and Gaussian filters, Homomorphic filtering.

UNIT - III Image Restoration and Image Compression **9**

Image Restoration - Degradation model, Properties, Noise Models, Mean Filters, Order Statistics, Adaptive filters, Notch Filters, Inverse Filtering, Wiener filtering, and Constrained Least Square Filtering. Data Redundancies - Image Compression Models - Huffman Coding, Arithmetic Coding, Run Length Coding, Lossless Predictive Coding - Image Compression Standards (JPEG and MPEG).

UNIT - IV Image Segmentation **9**

Edge Detection - Edge linking via Hough transform – Thresholding - Region-based Segmentation: Region Growing, Region Splitting and Merging - Morphological Processing: Erosion and Dilation - Segmentation by Morphological Watersheds (basic concepts).

UNIT - V Object Representation and Computer Vision Techniques **9**

Representation - Boundary Descriptors, Regional Descriptors - Chain Code, Structural Methods. Review of Computer Vision Applications: Fuzzy-Neural algorithms for Computer Vision Applications.

Total Hours: **45**

References:

1 Rafael C. Gonzalez & Richard E. Woods. (2010). *Digital Image Processing*. Pearson Education. 3rd Edition.

2 David A. Forsyth & Jean Ponce. (2012). *Computer Vision: A Modern Approach*. Pearson. 2nd Edition.

3 Anil. K. Jain. (2011). *Fundamental of Digital Image Processing*. Prentice-Hall of India Pvt.Ltd.

4 William K. Pratt. (2002). *Digital Image Processing*. John Wiley. 3rd Edition.

5 Kenneth R. Castleman. (2007). *Digital Image Processing*. Pearson Education India.

Course Outcomes:

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

CO1: Understand the fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D transforms.

CO2: Perform image enhancement using smoothing and sharpening filters (both in spatial and frequency domain).

CO3: Discuss the restoration concepts, filtering techniques, and basic compression methods.

CO4: Use various segmentation techniques and morphological algorithms for feature extraction.

CO5: Elaborate the image representation and computer vision applications.

CO - PO MAPPING

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

Digital Image Processing and Computer Vision Laboratory

Semester: VII **Hours of Instruction/week: 3P**

Course Code: 24BELC29 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To perform the basic operations on images.
CLO2: To design and implement algorithms for the real time image processing applications.

List of Experiments:

1. Basic operations on images.
2. Image sampling and quantization.
3. Intensity transformation of images.
4. Histogram processing and basic thresholding Functions.
5. Image enhancement- filtering in the spatial domain.
6. Image Enhancement- Filtering in the frequency domain.
7. Edge detection using various masks.
8. Global and adaptive thresholding.
9. Basic Morphological operations.
10. Image restoration.
11. Boundary / regional descriptors of an image.
12. Image compression using DCT / Wavelet transform

Total Hours: **45**

Course Outcomes:

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

CO1: Develop and implement algorithms to analyze the characteristics of images.
CO2: Perform edge detection and noise analysis operations in the images.
CO3: Apply image processing techniques to restore and represent the image features.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	3	-	-	-	2	2	-	1
CO2	2	2	3	2	3	1	-	-	2	2	-	2
CO3	2	2	3	2	3	1	-	-	2	2	-	2

Low Power VLSI Design

PE1 - Semester: VII **Hours of Instruction/Week: 3T**

No. of credits: 3

Course Code:24BELE09

Pre–Requisite: Power analysis and CMOS.

Course Learning Objectives (CLOs):

CLO1: To learn the need, analysis and estimation of low power devices.

CLO2: To understand the different optimization techniques to obtain low power.

CLO3: To study about low power static RAM architectures.

UNIT-I Introduction **9**

Introduction to low power VLSI design- Need for low power- Basic principles of low power design -Sources of Power dissipation(self-study)

UNIT-II Power Analysis and Estimation **9**

PowerAnalysis-Gatelevelanalysis-Architecturelevelanalysis-ProbabilisticPowerAnalysis Power estimation-Circuit level (self-study)–-High level power estimation.

UNIT-III Power Optimization Techniques **9**

Circuit-Logic- Special Techniques (self-study) –Architecture and Systems.

UNIT-IV Advanced Power Optimization Techniques **9**

Advanced Techniques-Low Power CMOS VLSI Design-Physics of Power Dissipation in CMOS FET Devices (self-study).

UNIT-V Low Power Static Ram Architectures **9**

Organization-MOS static RAM memory cell-banked organization(self-study)-voltage swing reduction-power reduction

Total Hours: **45**

References:

1 Gary Yeap. (2010). *Practical Low Power Digital VLSI Design*. Kluwer academic publishers, US.

2 Kaushik Roy., & Sharat C. Prasad., (2011). *Low Power CMOS VLSI circuit Design.* John Wiley & Sons, New Delhi.

Course Outcomes:

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

CO1: Discuss the need for low power, basic principles and sources of power dissipation.

CO2: Explain various levels of power analysis and estimation techniques.

CO3: Illustrate the different power optimization techniques in low power VLSI.

CO4: Comprehend the advanced power optimization techniques in low power VLSI.

CO5: Design the architecture of a low power SRAM circuit.

CO-PO MAPPING

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

Electronic Product Design

Hours of Instruction/Week:3T

PE1 - Semester: VII

Course Code:24BELE10 **No. of credits:3**

Pre–Requisite: Electronic Devices & Circuits, Basic Electrical Engineering ,Electronic Measurements and Instrumentation.

Course Learning Objectives (CLOs):

CLO1: Understand the basics, applications of electronic devices, PCB and RF systems.

CLO2: Push towards entrepreneurship and self-reliance in electronic product design aspects.

UNIT-I Design of Power Supplies 9

DC power supply - using transistors and SCRs, Design of crowbar and fold back protection circuits - Switched mode power supplies - Forward - fly back - buck and boost converters. Design of transformers and control circuits for SMPS.

UNIT-II Design of Data Acquisition Systems 9

Low level signals Amplification – Principles of Grounding - Shielding and Guarding techniques, A/D converters: Dual slope, quad slope and high speed - Microprocessors Compatible A/D converters, Logarithmic A/D converters - Sample and Hold circuit.

UNIT-III RF Design Methodology 9

Behaviour of RF passive components - Chip components and circuit board considerations -Review of transmission lines, Impedance and admittance transformation, Parallel and series connection of networks - ABCD and scattering parameters - RF filter – Basic resonator and filter configurations – Butterworth and Chebyshev filters. Implementation of microstrip filter. Band pass filter and cascading of band pass filter elements.

UNIT-IV RF Transistor Amplifier Design 9

Amplifier classes of operation and biasing networks – Amplifier power gain, Unilateral design – Simple input and output matching networks – Bilateral design – Stability circle - conditional stability - Simultaneous conjugate matching for unconditionally stable transistors - Broadband amplifiers, High power amplifiers. Multistage amplifiers.

UNIT-V Design of Printed Circuit Boards 9

Technology of printed circuit boards (PCB), General layout - rules and parameters - PCB design rules for Digital - High Frequency, Analog, Power Electronics and Microwave circuits. Computer Aided design of PCBs

Total Hours: **45**

References:

1. Reinhold Luduigand Pavel Bretchko.(2000).*RF Circuit Design–Theory and Applications.* Pearson Education.
2. Sydney Socl of. (2005).*Applications of Analog Integrated Circuits.* PHI.
3. Walter C Bosshart (2003). *Printed circuit Boards–Design and Technology.* Tata Mc Graw-Hill.
4. Keith H Billings.(2010).*Hand book of Switched Mode Supplies.* McGraw-Hill.
5. Michael Jaacob.(2000).A*pplications and Design with Analog Integrated Circuits* .PHI.
6. DM Pozar.(2008).*Microwave Engineering.* John Wiley.

Course Outcomes:

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

CO1: Design and develop simple electronic equipment for demonstration of Experimentation process.

CO2: Use the design methodology of few components in RF transmitter and receiver.

CO3: Discuss about analog and digital circuits using PCB.

CO4: Design and develop a standalone Data Acquisition System.

CO5: Knowledge of form and structure for the usability and aesthetics of electronic products and services.

CO - PO MAPPING

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

RF System Design

PE1 - Semester: VII **Hours of Instruction/week:3T**

Course Code:24BELE11 **No. of credits:3**

Pre–Requisite: Microwave and optical communication, Antennas and Wave Propagation, Electromagnetic fields.

Course Learning Objectives(CLOs):

CLO1: To design and analyze the issues in RFIC design.

CLO2: To design RF Amplifiers and RF Mixers design.

UNIT-I Issues in RFIC Design, Noise, Linearity and Filtering 9

Lower frequency analog design and microwave design versus radio frequency integrated circuit design - Impedance levels for microwave and low-frequency analog design- noise - linearity and distortion in RF Circuits - dynamic range - filtering issue.

UNIT-II Review of Technology 9

Small -signal model of bipolar transistor - high frequency effects - noise in bipolar transistors - base shot noise-noise sources in the transistor model - bipolar transistor design considerations-CMOS transistor.-impedance matching –tapped capacitors and inductors-the concept of mutual inductance - Tuning a transformer - bandwidth of an impedance transformation network-quality factor of an LC resonator.

UNIT-III Design of Passive Circuit Elements in IC Technologies 9

Technology backend and metallization in IC technologies –sheet resistance and skin effect-parasitic capacitance and inductance -current handling in metal lines-design of inductors and transformers - characterization of inductor-layout of spiral inductors - on-chip transmission lines - high frequency measurements of on-chip passives and common De-Embedding techniques-packaging.

UNIT-IV LNA and Power Amplifier 9

Basic amplifiers - amplifiers with feedback - noise in amplifiers - linearity in amplifiers –differential pair and other differential amplifiers-low-voltage topologies for LNAs and the use of on- chip transformers - DC bias networks - temperature effects - broad band LNA design. Power amplifier: power capability - efficiency calculations - matching considerations - Class A, B, C.D.E.F, G, H and S amplifiers.

UNIT-V Mixers 9

Mixing with nonlinearity-basic mixer operation-controlled transconductance mixer-double- balanced mixer - image reject and single -sideband mixers-alternative mixer designs.

Total Hours:**45**

References:

1. John Rogers and Calvin Plett. (2002).*Radio Frequency Integrated Circuit Design*. Artech House.
2. Stephan A Mass.(2003). *Non-Linear Microwave and RF circuits*. Artech House.
3. Ferri Losee.(2002).*RF Systems, Components and Circuits handbook*. Artech House.
4. Larson LE.(1997).*RF and Microwave Circuit for Wireless Applications*. Artech House.

Course Outcomes:

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

CO1: Solve the issues in the RFICs.
CO2: Design integrated circuits using transistors.
CO3: Design chip inductors and capacitors.
CO4: Design low noise and power amplifiers at high frequency.
CO5: Evaluate the mixer performance in RF system design.

CO-PO MAPPING

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

FPGA Based System Design

PE1 - Semester: VII **Hours of Instruction/week:3T**

Course Code:24BELE12 **No. of credits:3**

Pre–Requisite: Verilog HDL and Xilinx FPGA.

Course Learning Objectives (CLOs):

CLO1: To understand and learn Verilog HDL and FPGA Architectures.
CLO2: To understand Verilog modelling, Synchronous Sequential Circuit and System design using FPGA.

UNIT-I Overview of Verilog HDL **9**

Verilog HDL Coding Style: Lexical Conventions - Ports and Modules – Operators - Gate Level Modeling - System Tasks &Compiler Directives - Test Bench - Data Flow Modeling - Behavioral level Modeling -Tasks & Functions.

UNIT-II Overview of FPGA Architecture sand Technologies **9**

FPGA Architectural options, coarse vs fine grained, vendor specific issues (emphasis on Xilinx FPGA), Antifuse, SRAM and EPROM based FPGAs, FPGA logic cells, interconnection network and I/O Pad.

UNIT-III Verilog Modelling of Combinational and Sequential Circuits **9**

Behavioral, Data Flow and Structural Realization – Adders – Multipliers Comparators - Flip Flops - Realization of Shift Register - Realization of a Counter -Synchronous and Asynchronous FIFO – Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check.

UNIT-IV Synchronous Sequential Circuit **9**

State diagram-state table–state assignment-choice of flip-flops–Timing diagram–One hot encoding Mealy and Moore state machines – Design of serial adder using Mealy and Moore state machines - State minimization – Sequence detection Design examples: Sequence detector, Serial adder, and Vending machine using One Hot Controller.

UNIT-V System Design **9**

Examples using Xilinx FPGAs–Traffic light Controller, Real Time Clock-Interfacing using FPGA: VGA, Keyboard, LCD, Embedded Processor Hardware Design

Total Hours:**45**

References:

1 M.J.S Smith.(2000).*Application Specific Integrated Circuits*. Pearson.
2 Peter A shunned.(2007).*Digital Design using VHDL*. Elsevier.
3 Peter A shenden.(2007).*Digital Design using Verilog*. Elsevier.
4 W.Wolf.(2004).*FPGA based system design*. Pearson.
5 Clive Maxfield.(2004).*The Design Warrior's Guide to FPGAs*. Elsevier.
6 Samir Palnitkar.(2003).*Verilog HDL: A Guide to Digital Design and Synthesis*. Prentice Hall, 2nd Edition.

Course Outcomes:

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

CO1: Design and optimize complex combinational and sequential digital circuit.
CO2: Model Combinational and sequential digital circuits by Verilog HDL.
CO3: Design and model digital circuits with Verilog HDL at behavioral, structural, and RTL Levels.
CO4: Develop test benches to simulate combinational and sequential circuits.
CO5: Understand the FPGA Architecture and Implementation of the combinational and Sequential digital circuits in FPGA.

CO-PO MAPPING

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

5G Communication in IoT

PE2 - Semester: VII **Hours of Instruction/week:3T**

Course Code:24BELE29 **No. of credits:3**

Pre–Requisite: Mobile Communication.

Course Learning Objectives (CLOs):

CLO1: Understand the fundamental principles and technologies underlying 5G communication systems within the context of IoT applications including the key features, architecture and protocols involved.

CLO2: Analyze and evaluate the challenges and opportunities associated with deploying 5G communication networks in IoT environments.

UNIT-I 5G Radio Spectrum 9

5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios,5Gspectrum technologies, 5G Channel Model: The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, 5G use cases and requirements, 5G system concept.

UNIT-II Radio Interface Architecture 9

5G architecture options, core network architecture, RAN architecture, 5G physical layer: Physical channels and signals, 5G frame structure, physical layer procedures (MIMO, Power control, link adaptation, beam forming).

UNIT-III 5G Radio–Access Technologies 9

Access design principles for multi-user communications, multi-carrier with filtering: a new waveform, non-orthogonal schemes for efficient multiple access.

UNIT-IV Introduction to5GNetworkSlicing 9

Network Slicing, E2E Slicing, SDN and NFV Slicing, Vehicular Communications: From V2V to AV2X, key standards, VC architectures, V2X use cases.

UNIT-V Mobility and Hand off Management in 5G 9

Network deployment types, Interference management in5G, Mobility management in5G, Dynamic network reconfiguration in 5G.

Total Hours:**45**

References:

1 Afif Osseiran, Jose F Monserrat, Patrick Marsch.(2016).*5G Mobile and Wireless Communications Technology*. Cambridge University Press.

2 SaadZ. Asif.(2018).*5GMobile Communications Concepts and Technologies*. CRC Press, Taylor & Francis Group.1st Edition.

3 HarriHolma,AnttiToskala,TakehiroNakamura.(2020).*5GTechnology3GPPNEW RADIO*. John Wiley & Sons. 1st Edition.

4 Gordon L. Stuber.(2002).*Principles of Mobile Communication.* Kluwer Academic Publisher 2nd Edition.

5 Joseph C. Liberti, Theodore S .Rappaport.(1999).*Smart Antennas for Wireless Communications*. Prentice Hall PTR.

6 Ying Zhang.(2018).*Network Function Virtualization Concepts and Applicability in 5G Networks*. John Wiley & Sons.

Course Outcomes:

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

CO1: Understand 5G spectrum requirement and its channel model and use cases.

CO2: Familiarize with 5G architecture options and physical layer concepts.

CO3: Examine the multicarrier techniques and new waveform options for 5G communication.

CO4: Illustrate the concept of network slicing and V2VCommunication.

CO5: Interpret the Interference and Mobility management in 5G networks.

CO-PO MAPPING

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

Data Science for IoT

PE2 - Semester: VII **Hours of Instruction/week:3T**

Course Code:24BELE30 **No. of credits:3**

Pre–Requisite: Fundamentals of Programming (Python or R), Basics of Machine Learning.

Course Learning Objectives (CLOs):

CLO1: To provide necessary knowledge on data manipulation and to perform analysis on the practical problems using statistical and machine learning approach.

CLO2: To interpret performance evaluation results generated through R and visualize the results in graphical form using programming tool.

UNIT-I Introduction **9**

Data Science: Introduction to Data Science–Digital Universe–Sources of Data–Information Commons – Data Science Project Life Cycle: OSEMN Framework.

UNIT-II Data Preprocessing and Concept Learning **9**

Introduction to Data Preprocessing – Reading, Selecting, Filtering Data–Filtering Missing Values – Manipulating, Sorting, Grouping, Rearranging, Ranking Data - Formulation of Hypothesis – ProbabilisticApproximatelyCorrectLearning-VCDimension–Hypothesiselimination–Candidate Elimination Algorithm.

UNIT-III Essentials of Rand Model Fit using R **9**

R Basics - data types and objects - control structures – data frame -Feature Engineering - scaling, Label Encoding and One Hot Encoding, Reduction-Regression Models-Linear and Logistic Model, Classification Models–Decision Tree, Naïve Bayes, SVM and Random Forest, Clustering Models – K Means and Hierarchical clustering.

UNIT-IV Visualization **9**

Data visualization: Box plot, histogram, scatterplot, heat map–Working with Tableau–Outlier detection – Data Balancing.

UNIT-V Performance Evaluation in R **9**

Loss Function and Error :Mean Squared Error, Root Mean Squared Error–Model Selection and Evaluation criteria:Accuracy,Precision,F1score,RecallScore–Binary Predictive Classification–Sensitivity–Specificity.

Total Hours:**45**

References:

1 Ethem Alpaydin.(2020).*Introduction to Machine Learning*.MITPress.4th Edition.

2 Hadley Wickham, Garrett Grolemund.(2017).*R for data science: Import, Tidy, Transform, Visualize, And Model Data Paper back.*

3 Han,J.,Kamber,M.,Pei,J.(2011).*Data mining concepts and techniques.* Morgan Kaufmann.

4 CarlShan, Henry Wang, William Chen, Max Song.(2016).*The Data Science Handbook: Advice and Insight from 25Amazing Data Scientists.* The Data Science Bookshelf.

5 James,G.,Witten,D.,T.,Tibshirani,R.(2013).*An Introduction to statistical learning with Applications in R.* Springer.

6 Andreas C. Müller and Sarah Guido.(2016).*Introduction to Machine Learning with Python: A Guide for Data Scientists*. O'Reilly Media.

Course Outcomes:

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

CO1: Ability to gain basic knowledge on data science and convert the real time data into suitable form for analysis.

CO2: Gain the insights from the data through statistical inferences.

CO3: Develop suitable models using machine learning techniques and to analyze its Performance.

CO4: Identify the requirement and visualize the results.

CO5: Analyze on the performance of the model and the quality of the results.

CO-PO MAPPING

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

Sensors and Actuators

PE2 -Semester: VII **Hours of Instruction/week:3T**

Course Code:24BELE31 **No. of credits:3**

Pre–Requisite: Basic Electrical Engineering, Electronic Measurements and Instrumentation.

Course Learning Objectives (CLOs):

CLO1: To understand static and dynamic characteristics of measurement systems and learn different types of actuators, sensors and their applications.

CLO2: Acquire knowledge on self-generating sensors and its application.

UNIT-I Introduction to Measurement Systems 9

Introduction to measurement systems: General concepts and terminology - Measurement systems - Sensor classification - Performance characteristics: Static characteristics of measurement systems, accuracy, precision, sensitivity-Other characteristics: linearity, resolution, systematic errors, random errors - Dynamic characteristics of measurement systems: zero order, first-order, and second-order measurement systems and response.

UNIT-II Resistive and Reactive Sensors 9

Resistive sensors: Potentiometers, Strain gages, Resistive temperature detectors, Magneto resistors, Light-dependent resistors-Signal conditioning for resistive sensors: Wheat stone bridge, sensor bridge calibration and compensation –Reactance variation and Electromagnetic sensors-Capacitive sensors-Inductive sensors-Linear variable differential transformers (LVDT)-Magneto elastic sensors-Hall effect sensors.

UNIT-III Self-Generating Sensors 9

Self-generating sensors: Thermoelectric sensors, Piezoelectric sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors - Signal conditioning for self-generating sensors - Chopper and low-drift amplifiers - offset and drifts amplifiers - Electrometer amplifiers - Charge amplifiers - Noise in amplifiers.

UNIT-IV Actuators Drive Characteristics and Applications 9

Relays-Solenoid drive-Stepper Motors-Voice-Coil actuators-Servo Motors, DC motors and motor control - 4-to-20 mA Drive - Hydraulic actuators - Variable transformers: Synchros, Resolvers, Inductosyn, Resolver-to-Digital and Digital-to-Resolver converters.

UNIT-V Digital Sensors and Semiconductor Device Sensors 9

Digital sensors: Position encoders, Variable frequency sensors-Quartz digital thermometer-Vibrating wire strain gages-Digital flowmeters-49Sensors based on semiconductor junctions: Thermometers based on semiconductor junctions-Magneto diodes.

Total Hours:**45**

References:

1. Andrzej M.Pawlak.(2006).*Sensors and Actuators in Mechatronics Design and Applications*. Tylor and Francis.
2. D.Patranabis.(2003).*Sensors and Transducers*. MH.
3. Graham Brooker.(2009).*Introduction to Sensors for ranging and imaging.* Yesdee.
4. Herman K.P.Neubrat.(2022).*Instrument Transducers–An Introduction to Their Performance and Design.*OxfordUniversityPress.22.
5. ClarenceW.deSilva.(2007).*Sensors and Actuators: Control System Instrumentation.* CRC Press.
6. Ramon Pallás Areny.,& John G.Webster.(2000).*Sensors and Signal Conditioning*. John Wiley and Sons.2nd edition.
7. Kevin James.(2011).*PC Interfacing and Data acquisition.* Elsevier.
8. ClarenceW.deSilva.(2007).*Sensors and Actuators:Control System Instrumentation.* CRC Press.

Course Outcomes:

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

CO1: Understand the characteristics of measuring system and discuss functioning of sensors and actuators.
CO2: Compare the functionality of resistive sensors and reactive sensors.
CO3: Analyse the various real time applications of sensors and actuators.
CO4: Illustrate the concepts of relays and types of motors.
CO5: Discuss about digital sensor and semiconductor device sensor.

CO-PO MAPPING

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

Industry 4.0 and Industrial IoT

PE2 - Semester: VII **Hours of Instruction/Week:3T**

Corsecode:24BELE32 **No. of credits:3**

Pre–Requisite: Microprocessor and Microcontroller, Embedded systems, Fundamentals of IoT.

Course Learning Objectives (CLOs):

CLO1: Introduce how IIoT has become a game changer in the new economy.
CLO2: Introduce the tools and techniques that enable IIoT solution and Security aspects.

UNIT-I Industry4.0 **9**

Need – Reason for Adopting Industry 4.0 - Definition – Goals and Design Principles - LEAN Production Systems - Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Technologies in Industry 4.0 – Cyber security, Augmented Reality and Virtual Reality.

UNIT-II Industrial IoT **9**

Introduction, Industrial processes, Industrial sensing &Actuation - Business Model and Reference Architecture – Layers - IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking.

UNIT-III IIoT Analytics **9**

Big Data and Advanced Analytics-Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

UNIT-IV IIoT Security **9**

Security and Fog Computing- Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT.

UNIT-V Case Study **9**

IIoT Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Smart Metering, e-Health & Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Milk Processing and Packaging Industries, Manufacturing Industries.

Total Hours**:45**

References:

1. Alasdair Gilchrist. (2016).*Industry4.0:The Industrial Internet of Things.* Apress.
2. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat.(2017).*Industrial Internet of Things: Cyber manufacturing Systems.* Springer.
3. Giacomo Veneri, Antonio Capasso.(2018).*Hands-On Industrial Internet of Things: Create a powerful Industrial IoT.* Packt.
4. Red Lion.(2018).*How Protocol Conversion Addresses IIoT Challenges.* Whitepaper.

Course Outcomes:

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

CO1: Outline the basic concepts and technologies of Industry 4.0.

CO2: Explore key IIoT concepts including sensors, processing, wireless protocols, and data storage.

CO3: Understand various technologies, analytics and Applications.

CO4: Evaluate and give solutions for IIOT Security and Data protection.

CO5: Connect numerous IOT applications with the physical world of humans and real life problem solving.

CO-PO MAPPING

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

School of Engineering

Disaster Management

(Non – Credit Mandatory Course)

(Applicable for the B.E students admitted from the academic year 2024-2025 & onwards)

Semester: VII **Hours of Instruction/week: 3T**

Course Code: 24BEMC07

Course Learning Objectives (CLOs):

CLO1: To enable the students to create an awareness on Disasters and its types,

CLO 2: To study the risk management and development policies implemented by the government to protect from disaster.

UNIT –I Introduction to Disasters **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc. - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT –II Approaches to Disaster Risk Reduction (DRR) **9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- non-structural measures, Roles and responsibilities of-community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level-State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT - III Inter-Relationship between Disasters and Development **9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT - IV Disaster Risk Management in India **9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, and Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in

Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT - V Disaster Management: Applications and Case Studies and Field Works 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

Total Hours: **45**

References:

1 Ghosh G.K. (2011). *Disaster Management*. APH Publishing Corporation.
2 Singhal J.P. (2019).*Disaster Management*. Laxmi Publications.
3 Tushar Bhattacharya. (2017).*Disaster Science and Management.* McGraw Hill India Education Pvt. Ltd.,
4 Gupta Anil K & Sreeja S. Nair. (2011). *Environmental Knowledge for Disaster Risk Management.* NIDM,New Delhi.
5 Anu Kapur. (2010).*Vulnerable* India: A Geographical Study of Disasters. IIAS and Sage Publishers, New Delhi.
6 *Govt. of India: Disaster Management Act*, Government of India, New Delhi, 2005.
7 *Government of India*, National Disaster Management Policy,2009.
8 http://ndma.gov.in/ (Home page of National Disaster Management Authority)

Course Outcomes:

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

CO1: Discuss the basics of disasters, types and their impacts.
CO2: Explain about the Disaster Risk Reduction strategies and policies
CO3: Familiarize with the relationship between disasters and development.
CO4: Describe the disaster risk management policies and acts implemented in India.
CO5: Summarize case studies related to various disasters.

CO - PO MAPPING

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

Department of Electronics and Communication Engineering

Sensors

(Open Elective Course)

(Applicable for the B.E students admitted in the other engineering departments from the academic year 2024-2025 & onwards)

Semester: VII **Hours of Instruction/week:3T**

Course Code:24BELO01 **No. of credits:3**

Course Learning Objectives (CLOs):

CLO1: To provide in-depth understanding of the principle of measurement, and theory of instruments and sensors for measuring velocity and acceleration.

CLO2: Apply the use of sensors for measurement of displacement, force and pressure.

UNIT-I Sensor fundamentals and characteristics **9**

Sensor Classification, Performance and Types, Error Analysis characteristics.

UNIT-II Intelligent Sensors **9**

General Structure of smart sensors & its components - Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.

UNIT-III Intensity Polarization and Interferometry Sensor **9**

Intensity sensor, Micro bending concept, Interferometers, Mach Zehnder, Michelson, Fabry Perot and Sagnac, Phase sensor: Phase detection, Polarization maintaining fibers.

UNIT-IV Strain, Force, Torque and Pressure sensors **9**

Strain gages - Strain gage beam force sensor, Piezoelectric force sensor, Load cell, Torque sensors, Piezo- resistive and Capacitive pressure sensor - Optoelectronic pressure sensors - Vacuum sensors.

UNIT-V Position, Direction, Displacement and Level sensors **9**

Potentiometric and capacitive sensors, Inductive and magnetic Sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, Magneto resistive, Magnetostrictive sensors. Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor.

Total Hours: **45**

References:

1 D.Patranabis.(2003).*Sensors and Transducers*. PHI Learning Private Limited.

2 Johnveteline, aravindraghu.(2011).*Introduction to sensors*. CRC press.

3 DVS Murthy.(2013). *Transducers and Instrumentation.* PHI 2nd Edition.

4 Hermann K.P. Neubert.(2012).Instrument Transducers. Oxford University Press. 2nd Edition.

5 Arun K. Ghosh (2012). *Introduction to measurements and Instrumentation*. PHI. 4th Edition.

Course Outcomes:

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

CO1: Understand the concepts in common methods for converting a physical parameter into an electrical Quantity.

CO2: Explain the general structure in smart sensors and its characteristics.

CO3: Evaluate performance characteristics of different types of sensors

CO4: Create analytical design and development solutions for sensors.

CO5: Illustrate the basic concepts & characteristic of sensors

CO-PO MAPPING

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

Department of Electronics and Communication Engineering

Drone Technologies
(Open Elective Course)
(Applicable for the B.E students admitted in the other engineering departments from the academic year 2024-2025 & onwards)

Semester: VIII **Hours of Instruction/week: 3T**

Course Code: 24BELO02 **No.of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To learn the basics of drone concepts, design, fabrication and programming of drone.
CLO2: To impart the knowledge of a flying and operation of drone.
CLO3: To know about the various applications of drone and understand the safety risks and guidelines.

UNIT-I Introduction to Drone Technology **9**

Drone Concept –Vocabulary Terminology- History of drone –Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses-Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability.

UNIT-II Drone Design and Programming **10**

Classifications of the UAV –Overview of the main drone parts-Technical characteristics of the parts-Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations-The methods of programming drone-Download program-Install program on computer-Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT-III Drone Flying and Operation **9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment Drone controls Flight operations-management tool-Sensors-Onboard storage capacity-Removable storage devices- Linked mobile devices and applications.

UNIT-IV Drone Commercial Applications **9**

Choosing drone based on the application-Drones in the insurance sector-Drones in delivering mail, parcels and other cargo-Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing.

UNIT-V Future Drones and Safety **8**

The safety risks-Guidelines to fly safely –Specific aviation regulation and standardization-Drone license- Miniaturization of drones- Increasing autonomy of drones –The use of drones in swarms.

Total Hours: **45**

References:

1 Daniel Tal and John Altschuld. (2021). *Drone Technology in Architecture, Engineering and Construction:A strategic Guide to Unmanned Aerial Vehicle Operation and Implementation*. John Wiley & Sons, Inc.

2 Terry Kilby and Belinda Kilby.(2016).*Make: Getting Started with Drones*. Maker Media, Inc.

3 John Baichtal. (2016).*Building Your Own Drones: A beginners' Guide to Drones, UAVs, and ROVs*.Que Publishing.

4 Zavrsnik.(2018).*Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance.* Springer.

5 Paul Aitken.(2020). *Drone Photography & Video Master class*. Ammonite Press.

6 Adam Juniper.(2021).*The Complete Guide to Drones: Extended*. Ilex Press. 3rd Edition.

Course Outcomes:

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

CO1: Know about various type of drone technology, drone fabrication and programming.

CO2: Execute the suitable functioning procedures for a drone.

CO3: Select appropriate sensors and actuators for drones.

CO4: Develop a drone mechanism for specific applications.

CO5: Understand the future drone technologies and its safety.

CO-PO MAPPING

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

Department of Electronics and Communication Engineering

IoT in Connected Cars

(Open Elective Course)

(Applicable for the B.E students admitted in the other engineering departments from the academic year 2024-2025 & onwards)

Semester: VIII **Hours of Instruction/week: 3T**
Course Code: 24BELO03 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To familiarize with Automotive electronics and Understand the concepts of Automotive system.

CLO2: To analyze Connected cars and its applications and develop application modules for Connected Cars and Smart Cars.

UNIT - I Fundamentals of Connected Cars **9**

Introduction-Automated-Connected and Intelligent Vehicles - Automotive Electronics -Overview CAN-UDS protocol - ECU operation- Networking of ECU-On Board Diagnostics- Advanced OBD - Failure Modes and Self Calibration- Real Time On Board Parameters- Cloud Connectivity- Testing and Validation.

UNIT - II Electronics in Automobile **9**

Introduction-Body and convenience electronics: vehicle power supply controllers and lighting modules, door control modules, Safety electronics: active safety systems: ABS, ASR, ESP passive safety systems: Restraint systems and their associated sensors in an automobile. Infotainment electronics: Dashboard/instrument cluster, car audio, telematics systems, navigation systems, multimedia systems.

UNIT - III Sensors and Actuators **9**

Classification of sensors, sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, Accelerometer, Sensor, Coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors and relay.

UNIT - IV Connected Car Technology **9**

Connectivity Fundamentals M2M- V2V-V2I- ETSI Standards for V2V.Navigation and Other Applications -ADAS- Sensor Technology for Advanced Driver-Assistance Systems - Basics of Radar - LIDAR- Camera -Ultrasonic Sonar-Technology and Systems Integration of Sensor Data to On-Board Control Systems.

UNIT - V Architectures for Vehicular Communication Systems **9**

Vehicle-to infrastructure Communications-Performance of cellular Communication-System model for the evaluation of the impact of V2I communications on LTE resource utilization - Channel- aware V2I Communications for efficient utilization of cellular resources.

Total Hours: **45**

References:

1. Knowles.D.(2009). *Automotive Electronic and Computer Controlled Ignition Systems.* Prentice Hall Publications. New Jersey.
2. Ronald K.J .(2009).*Automotive Electronics Handbook.* McGraw Hill Publications. Columbus.
3. Wai Chen.(2015). *Vehicular Communications and Networks.* Wood head publishing is an imprint of Elsevier. Cambridge. UK.
4. Vieweg. (2014). *Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive*. ISBN 978-3-658-01784-2

Course Outcomes:

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

CO1: Discuss the technology of developed Autonomous Cars.

CO2: To obtain the knowledge of Automotive Electronics.

CO3: Identify the role of Sensors and Identify the appropriate sensors for Automotive Application.

CO4: Describe the characteristics of various communication systems and analyse the role of Sensors in ADAS.

CO5: Illustrate the V2I for vehicle safety and enhanced operations.

CO - PO MAPPING

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

Syllabus for Honor Specialization (Optional)

Internet of Things

Department of Electronics and Communication Engineering

B.E. Honors (Internet of Things)

(Applicable for the B.E Electronics and Communication Engineering students admitted from the academic year 2024-2025 & onwards)

Part	*Semester*	*Course Code*	*Name of Course/component*
III	V	24BELH01	Energy Harvesting Technologies and Power Management for IoT Devices
		24BELH02	Privacy and Security in IoT
	VI	24BELH03	Cognitive IoT
		24BELH04	Communication Technologies for IoT
	To be completed between 5th to 7th semesters	24BELH51/ - 24BELH60	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
		24BELH61/ - 24BELH70	**MOOC (12 Weeks Course in SWAYAM – NPTEL**

Department of Electronics and Communication Engineering

Energy Harvesting Technologies and Power Management for IoT Devices

Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BELH01 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study the basic energy harvesting system, modelling, non-linear technique and its application.
CLO2: To analyze about different types of power generation.

UNIT - I Energy Harvesting Systems **9**

Introduction–Energy sources–energy harvesting based sensor networks –photo voltaic cell technologies–generation of electric power in semiconductor PV cells types.

UNIT - II Piezo- Electric Energy Harvesting and Electro mechanical Modeling **9**

Piezo electric materials – transducers – harvesters – micro generators – strategies for enhancing the performance of energy harvesters. Electromechanical modeling of Lumped parameter model and coupled distributed parameter models and closed–form solutions.

UNIT - III Electromagnetic Energy Harvesting and Non-Linear techniques **9**

Basic principles–micro fabricated coils and magnetic materials –scaling–power maximations– micro and macro scale implementations. Non – linear techniques – vibration control & steady state cases.

UNIT - IV Energy harvesting Wireless Sensors **9**

Power sources for WSN–Power generation–conversion–examples–case studies. Harvesting micro electronic circuits–power conditioning and losses.

UNIT - V Selected Applications of Energy Harvesting Systems **9**

Case studies for Implanted medical devices – Bio –MEMS based applications – harvesting for RF sensors and ID tags –powering wireless SHM sensor nodes.

Total Hours: **45**

References:

1 Carlos Manuel Ferreira Carvalho. (2016).*CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications*. Springer.

2 Danick Briand., & Shad Roundy.(2015).Micro Energy Harvesting. Springer.

Course Outcomes:

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

CO1: Understand the various energy sources harvesting based sensor networks.

CO2: Discuss about the various Piezo electric energy harvesting materials.

CO3: Describe the characteristics of non-linear techniques.

CO4: Analyze the power of WSN and its losses.

CO5: Illustrate the MEMS based application and sensor nodes.

CO - PO MAPPING

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

Privacy and Security in IoT

Semester: V **Hours of Instruction/week: 3T**

Course Code:24BELH02 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the Security requirements in IoT and cryptographic fundamentals for IoT.
CLO2: To learn the authentication credentials, access control and various types Trust models for Cloud Security.

UNIT - I Introduction: Securing the Internet of Things **9**

Security Requirements in IoT Architecture-Security in Enabling Technologies-Security Concerns in IoT Applications. Security Architecture in the Internet of Things-Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control -Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities –Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices – Transport Encryption–Attack &Fault trees.

UNIT - II Cryptographic Fundamentals for IoT **9**

Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographiccontrolsbuiltintoIoTmessagingandcommunicationprotocols–IoTNodeAuthentication.

UNIT - III Identity & Access Management Solutions for IoT **9**

Identity lifecycle–authentication credentials–IoT IAM infrastructure–Authorization with Publish/Subscribe schemes–access control.

UNIT - IV Privacy Preservation and Trust Models for IoT **9**

Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT–self-organizing Things-Preventing unauthorized access.

UNIT - V Cloud Security for IoT **9**

Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – An enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing.

Total Hours: **45**

References:

1 Syed Rameem Zahra., & Mohammad Ahsan Chishti. (2020).*Security and Privacy in the IoT*. Chapman and Hall/CRC.1st edition.

2 Hu, Fei.(2016).*Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations.*CRC Press. 1st edition.

3 Sandeep Saxena., & Ashok kumar Pradhan.(2022).*Internet of Things Security & Privacy in Cyber space.* TCSN. Springer.

Course Outcomes:

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

CO1: To design security in IOT devices and deployments, and highlight where designs and deployments may have security issues.

CO2: Explain basic concepts and algorithms of cryptography, including encryption/ decryption and hash functions.

CO3: Understand the authentication credentials and access control

CO4: Discuss the mechanisms and architectures of various types trust models and cloud security.

CO5: Illustrate the IoT cloud security architecture and its directions.

CO - PO MAPPING

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

Cognitive IoT

Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BELH03 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: Impart the knowledge types of sensor and to perform further data analytics.

CLO2: Analyze the FPGA interfacing with IoT based edge devices and its applications.

UNIT - I Cognitive IoT – Introduction **9**

Cognitive IoT, Need for Cognitive IoT, Current and Future trends of IoT, Cognitive computing and applications

UNIT - II Data Analytics **9**

Data Analytics for IoT Regression, Data Analytics for IoT ANN Classification, Data Analytics for IoT Modern DNN's.

UNIT - III FPGA for Internet of Things **9**

Benefits of FPGA, Interfacing FPGAs with IoT-based edge devices, IoT-FPGA based applications, Micro semi's SmartFusion2 SoC FPGA

UNIT - IV IoT Enabling Technologies and Devices **9**

Big data, Digital twin, Cloud Computing, Sensors, Communications, Analytical software, Edge Devices.

UNIT - V Security in Cognitive IoT **9**

Security in Cognitive IoT, Security Issues in IoT, A hardware assisted approach for security, Architectural level overview for providing security, Security threats.

Total Hours: **45**

References:

1 Gurudatta patra., & Verma. (2022).*Cognitive IoT*. Taylor & Francis .1st edition.

2 Pethuru Raj & Anupama.(2022).*Cognitive Internet of Things Enabling Technologies, Platforms, and Use Cases.* Auerbach Publications.1st edition.

3 Matin., & Mohammad Abdul.(2020). Towards Cognitive IoT Networks. Springer 1st edition.

Course Outcomes:

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

CO1: Understand the needs of Cognitive in IoT.
CO2: Comprehend the data analytics for IoT regression and its ANN classification.
CO3: Design on interfacing FPGA with IoT-based edge devices.
CO4: Illustrate the characteristics of IoT enabling technologies and devices.
CO5: Analyze security issues in IoT applications.

CO - PO MAPPING

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

Communication Technologies for IoT

Semester: VI **Hours of Instruction/week: 3T**

Course Code:24BELH04 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To learn the fundamental Communication technologies and standards for IoT.
CLO2: Analyze the basic concepts of cellular standards & WLAN bridges.

UNIT - I RF Basics: Radio Frequency(RF) Fundamentals **9**

Introduction to RF & Wireless Communications Systems, RF and Microwave Spectral Analysis, Communication Standards, Understanding RF & Microwave Specifications. Spectrum Analysis of RF Environment, Protocol Analysis of RF Environment, Units of RF measurements, Factors affecting network range and speed, Environment, Line-of-sight, Interference, Defining differences between physical layers-OFDM.

UNIT - II Cellular Standards **9**

Cellular carriers and Frequencies, Channel allocation, Cell coverage, Cell Splitting, Microcells, Pico cells, Handoff, 1st, 2nd, 3rd and 4th Generation Cellular Systems (GSM, CDMA, GPRS,EDGE, UMTS), Mobile IP,WCDMA.

UNIT - III WLAN: Wi-Fi Organizations and Standards **9**

IEEE, Wi-Fi Alliance, WLAN Connectivity, WLAN QoS& Power-Save,IEEE802.11 Standards,802.11-2007,802.11a/b/g,802.11e/h/I,802.11n

UNIT - IV Wi-Fi Hard ware & Software **9**

Access Points, WLAN Routers, WLAN Bridges, WLAN Repeaters, Direct-connect Aps, distributed connect Aps, PoE Infrastructure, End point, Client hardware and software ,Wi-Fi Applications.

UNIT - V WSN&WPN **9**

Wireless Personal Area Networks, Bluetooth, Bluetooth Standard, Bluetooth Protocol Architecture, UWB, IEEE 802.15 standards, ZigBee, Sub1GHz, Sensor Networks, coexistence strategies in Sensor Networks, Routing protocols in Wireless Sensor Networks.

Total Hours: **45**

References:

1 Rolando Herrero (2022).*Fundamentals of IoT communication technologies*.TTE publishing .

2 Ajay Prasad (2022). *Communication Technologies and Security Challenges in IoT.* ITTCC Publishing.

3 Holger Karl and Andreas Wiilig. (2008). *Protocols and Architectures for Wireless Sensor Netwo rks J*ohn Wiley & Sons Limited.

Course Outcomes:

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

CO1: Explain communication standards, spectrum, Protocol analysis and factors affecting Network range in RF and wireless communication system.

CO2: Analyze the characteristics of cellular standards and its applications.

CO3: Identify different Wi-Fi organization and its standards.

CO4: Illustrate hard ware devices in Wi-Fi, protocols and standards in WPN, WSN.

CO5: Understand the various of routing protocols in Wireless sensor Networks.

CO - PO MAPPING

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

Syllabus for Minor Specialization (Optional)

Wearable Technology

Department of Electronics and Communication Engineering

B.E. Minor Specialization (Wearable Technology)

(Applicable for the B.E students admitted in the other under graduate engineering departments from the academic year 2024-2025 & onwards)

Part	*Semester*	*Course Code*	*Name of Course/component*
III	**V**	24BELE04	Nano and Flexible Electronics
		24BELE27	Wireless Sensor Networks
	VI	24BELE25	Printed and Wearable Electronics
		24BELE31	Sensors and Actuators
	To be completed between 5th to 7th semesters	24BELM01/ - 24BELM10	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
		24BELM11/ - 24BELM20	**MOOC (12 Weeks Course in SWAYAM – NPTEL**

Department of Electronics and Communication Engineering

Nano and Flexible Electronics

Semester: V **Hours of Instruction/week:3T**

Course Code: 24BELE04 **No. of credits:3**

Course Learning Objectives (CLOs):

CLO1: To enable the students to learn the basics of nanoscience and nanotechnology.
CLO2: Understand the materials and methods used for the fabrication of flexible electronics.

UNIT-I Introduction to Nano Electronics **9**

Electronic states in crystal energy bands, Concepts of 2D nanostructures (quantum wells), 1D nanostructures (quantum wires), 1D nanostructures (quantum dots), artificial atomic clusters, Size dependent properties, Size dependent absorption spectra, Blue shift with smaller sizes, Phonons in nanostructures.

UNIT-II Basics of Flexible Electronics **9**

Introduction to Flexible and Printed Electronics and their Materials Systems, Background and history, emerging technologies, general applications, Review of Semiconductors and Circuit Elements, Carrier transport, doping, band structure, and thin-film electronic devices.

UNIT-III Flexible Devices Fabrication and Materials **9**

Thin-film Deposition and Processing Methods for Flexible Devices, CVD, ECVD, PVD, etching, photolithography, low-temperature process integration, Materials for Flexible and Printed Electronics: Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, paper-based electronics, textile substrates, barrier materials.

UNIT-IV Thin Film Transistors **9**

Thin Film Transistors device structure and performance: I-V characteristics, Mechanics of Thin-films and Flexible Thin-film Transistors: thin-film mechanics models, neutral plane, conformal electronics, mechanical modeling

UNIT-V Applications and Economics **9**

Flexible Electronics Applications: Displays, sensor arrays, memory devices, MEMS, lab-on-a- chip, and photovoltaic, Introduction to Cost Models and Economics of Printed Flexible Electronics: Overview of display industry cost models, cost advantages and disadvantages for printed electronics, Scaling of large-area flexible systems, cost of goods sold for display applications.

Total Hours:**45**

References:

1 Takao Someya. (2013). *Stretchable Electronics*. Wiley International, U.S.

2 Guozhen Shen, Zhiyong Fan.(2016).*Flexible Electronics: From Materials to Devices*. World Scientific, U.S.

3 ChuanSeng Tan,Qing Zhang,Wei Lei.(2021).*Nano electronics: Materials, Devices, Applications and Challenges* .Springer.

4 George K. Knopf, Sergey Edward Lyshevski.(2022).*Flexible Electronics: Materials and Applications.* CRC Press.

5 Chris Dwyer.(2023).*Nano and Flexible Electronics: Materials, Devices, and Applications*. Wiley.

6 Omar Manasreh.(2024).*Nanotechnology and Nanoelectronics:Principles,Devices, Measurements, and Applications*. CRC Press.

7 Stergios Logo thetidis.(2023).*Flexible and Nano-Electronics:Principles,Materials,and Applications*. Springer.

Course Outcomes:

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

CO1: Interpret technical information about the basics of nano electronics.

CO2: Understand the materials, fabrication techniques and design principles specific to Flexible electronic devices.

CO3: Designlayouts,exemplarycircuitsandflexibleelectronicdeviceswiththegained Knowledge on flexible electronic materials and technology.

CO4: Analyse the characteristics and performance metrics of TFT's.

CO5: Indicate main objectives and application areas of flexible electronics with an Understanding of their economics.

CO-POMAPPING

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

Wireless Sensor Networks

Semester: V **Hours of Instruction/week:3T**

Course Code:24BELE27 **No.ofcredits:3**

Course Learning Objectives(CLOs):

CLO1: To learn about overview of wireless sensor networks, architectures and its Protocols
CLO2: To understand the concepts of infrastructure establishment, network platforms and tools.

UNIT-I Overview of Wireless Sensor Networks **9**

Challenges for wireless sensor networks, Comparison of sensor network with adhoc network. Sensor Localization, Clock synchronization, Power management, Special WSNs, WSN Applications.

UNIT-II Architecture **9**

Single-Node Architecture-Hardware Components, Energy Consumption of Sensor Nodes Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT-III Networking Sensors **9**

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

UNIT-IV Infrastructure Establishment **9**

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT-V Sensor Network Platforms and Tools **9**

Sensor Node Hardware –Berkeley Motes, Programming Challenges, Node level software platforms, Node-level Simulators, State-centric programming

Total Hours:**45**

References:

1 Holger Karl &Andreas Willig.(2005).*Protocols and Architectures for Wireless Sensor Networks*. John Wiley.

2 FengZhao.,&Leonidas J.Guibas.(2007).*Wireless Sensor Networks-an Information Processing Approach*. Elsevier.

3 Kazem Sohraby.,Daniel Minoli.,&Taieb Znati.(2007).*Wireless Sensor Networks-Technology, Protocols And Applications*. John Wiley.

4 Anna Hac.(2003).*Wireless Sensor Network Designs*. John Wiley.

5 Carlos DeMorais Cordeiro.,& Dharma Prakash Agarwal.(2006).*Ad Hoc &Sensor Networks: Theory and Applications*. World Scientific Publishing Company.

Course Outcomes:

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

CO1: Illustrate the challenges and applications of wireless sensor networks.

CO2: Explain the network architecture of WSN in various aspects.

CO3: Design MAC and routing protocols for wireless sensor networks.

CO4: Illustrate the concept of infrastructure establishment of WSN.

CO5: Discuss about various sensor network platforms and tools.

CO-PO MAPPING

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

Printed and Wearable Electronics

Semester: VI **Hours of Instruction/week:3T**

Course Code:24BELE25 **No.of credits:3**

Course Learning Objectives(CLOs):

CLO1: To understand the need for wearable devices and its application on various sectors such as healthcare, sports, environment monitoring and navigation.

CLO2: Critically assess the usability and societal impact of various types of wearable devices in different contexts and industries.

UNIT-I Introduction to Wearable Devices and Sensors 9

Emergence of wearable computing and wearable electronics -Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing - Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety - Wearable Inertial Sensors-Accelerometers, Gyroscopic sensors and Magnetic sensors – Wearable Sensors-In- Shoe Force and Pressure Measurement - Applications: Fall Risk Assessment, Fall Detection , Gait Analysis, Human Kinetics, Cardiac Activity.

UNIT-II Wearable Devices for Healthcare 9

Electrode- geometry, material -Fabrication of Inter Digitated (IDE) electrodes, choice of substrate, sensing film - Wearable ECG devices: Basics of ECG and its design, Electrodes and the Electrode Skin Interface - Wearable EEG devices: Principle and origin of EEG, Basic Measurement set- up, electrodes and instrumentation - Wearable EMG devices: EMG Signals, EMG Measurement, Wearable surface electrodes - Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuff less Blood Pressure Monitor - Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring - Detection principles – thermistor, infrared radiation - Modality of measurement.

UNIT-III Wearable Biochemical and Gas Sensors 9

Wearable Biochemical Sensors: Parameters of interest –Textile based –Micro needle based - Types: Non-invasive Glucose Monitoring Devices - Pulse oximeter – Portable Pulse Oximeters - Wearable pulse oximeter - Wearable capnometer for monitoring of expired carbon dioxide - Wearable gas sensors: Metal Oxide (MOS) type, electrochemical type - Detection of atmospheric pollutants.

UNIT-IV Wearable Cameras and Microphones for Navigation 9

Cameras in wearable devices - Applications in safety and security -Navigation - Automatic digital diary-Camerasinsmart-watches-UseofWearableMicrophones-MEMSmicrophones-

Bioacoustics - Wearable Assistive Devices for the Blind - Hearing and Touch sensation - Assistive Devices for Fingers and Hands – Assistive Devices for wrist, vests and belts, head-mounted devices.

UNIT-V Other Wearable Devices 9

Wearable devices with Global Positioning System (GPS) integration for tracking and navigation - Wearable Optical Sensors - UV exposure indicators - Speech recognition using lasers - Photo Plethysmography (PPG) - 3D imaging and motion capture.

Total Hours:**45**

References:

1 Toshiyo Tamura and Wenxi Chen.(2018).*Seamless Healthcare Monitoring*. Springer.

2 Edward Sazonov and Michael R.Neuman.(2014).*Wearable Sensors-Fundamentals, Implementation and Applications*. Elsevier Inc.

3 AiméLay-Ekuakille and Subhas Chandra Mukhopadhyay.(2010).*Wearable and Autonomous Biomedical Devices and Systems for Smart Environment* .Springer.

4 Subhas Chandra Mukhopadhyay.(2015).*Wearable Electronics Sensors-For Safe and Healthy Living* .Springer.

5 Shantanu Bhattacharya,A K Agarwal,Nripen Chanda,Ashok Pandey and AshisKumar Sen. (2018). *Environmental, Chemical and Medical Sensors*. Springer Nature Singapore Pvt. Ltd.

6 XiaojunGuo.(2023).*Printed and Flexible Electronics: Fabrication, Materials, and Applications*. Springer

7 SimonM.Sze.(2024).*Printed Electronics:Materials, Technologies and Applications*. Springer.

Course Outcomes:

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

CO1: Explain the components and functionalities of wearable devices including sensors, data Processing units and communication modules.

CO2: Analyze the design and development of wearable bio-electrode for developing monitoring devices for health care applications.

CO3: Discuss and analyze the usage of various biochemical and gas sensors for environment monitoring.

CO4: Identify the use of various wearable locomotive tools for navigation and other real time applications.

CO5: Explore a variety of emerging wearable devices beyond health care and navigation such as smart textiles, augmented reality glasses and speech recognition devices.

CO-PO MAPPING

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

Sensors and Actuators

Semester: VI **Hours of Instruction/week:3T**

CourseCode:24BELE31 **No. of credits:3**

Course Learning Objectives (CLOs):

CLO1: To understand static and dynamic characteristics of measurement systems and learn different types of actuators, sensors and their applications.

CLO2: Acquire knowledge on self-generating sensors and its application.

UNIT-I Introduction to Measurement Systems 9

Introduction to measurement systems: General concepts and terminology - Measurement systems - Sensor classification - Performance characteristics: Static characteristics of measurement systems, accuracy, precision, sensitivity-Other characteristics: linearity, resolution, systematic errors, random errors - Dynamic characteristics of measurement systems: zero order, first-order, and second-order measurement systems and response.

UNIT-II Resistive and Reactive Sensors 9

Resistive sensors: Potentiometers, Strain gages, Resistive temperature detectors, Magneto resistors, Light-dependent resistors-Signal conditioning for resistive sensors: Wheat stone bridge, sensor bridge calibration and compensation –Reactance variation and Electromagnetic sensors-Capacitive sensors-Inductive sensors-Linear variable differential transformers (LVDT)-Magneto elastic sensors-Hall effect sensors.

UNIT-III Self-Generating Sensors 9

Self-generating sensors: Thermoelectric sensors, Piezoelectric sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors - Signal conditioning for self-generating sensors - Chopper and low-drift amplifiers - offset and drifts amplifiers - Electrometer amplifiers - Charge amplifiers - Noise in amplifiers.

UNIT-IV Actuators Drive Characteristics and Applications 9

Relays-Solenoid drive-Stepper Motors-Voice-Coil actuators-Servo Motors, DC motors and motor control - 4-to-20 mA Drive - Hydraulic actuators - Variable transformers: Synchros, Resolvers, Inductosyn, Resolver-to-Digital and Digital-to-Resolver converters.

UNIT-V Digital Sensors and Semiconductor Device Sensors 9

Digital sensors: Position encoders, Variable frequency sensors-Quartz digital thermometer-Vibrating wire strain gages-Digital flowmeters-49Sensors based on semiconductor junctions: Thermometers based on semiconductor junctions-Magneto diodes.

Total Hours:**45**

References:

1. Andrzej M.Pawlak.(2006).*Sensors and Actuators in Mechatronics Design and Applications*. Tylor and Francis.
2. D.Patranabis.(2003).*Sensors and Transducers*. MH.
3. Graham Brooker.(2009).*Introduction to Sensors for ranging and imaging.* Yesdee.
4. HermanK.P.Neubrat.(2022).*Instrument Transducers–An Introduction to Their Performance and Design*.OxfordUniversityPress.22.
5. ClarenceW.deSilva.(2007).*Sensors and Actuators: Control System Instrumentation*. CRC Press.
6. Ramon Pallás Areny.,& John G.Webster.(2000).*Sensors and Signal Conditioning*. John Wiley and Sons.2nd edition.
7. Kevin James.(2011).*PC Interfacing and Data acquisition*. Elsevier.
8. ClarenceW.deSilva.(2007).*Sensors and Actuators: Control System Instrumentation*. CRC Press.

Course Outcomes:

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

CO1: Understand the characteristics of measuring system and discuss functioning of sensors and actuators.

CO2: Compare the functionality of resistive sensors and reactive sensors.

CO3: Analyse the various real time applications of sensors and actuators.

CO4: Illustrate the concepts of relays and types of motors.

CO5: Discuss about digital sensor and semiconductor device sensor.

CO-PO MAPPING

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