



Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore 641 043, Tamil Nadu, India

SCHOOL OF ENGINEERING

Syllabus

(For students admitted from 2021-2022 and onwards)

B.E Degree Course

in

Electronics and Communication Engineering



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.

Corrected Scheme of Instruction & Examination

(For students admitted from 2021-2022 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	Credits
First Semester									
I		Humanities and Social Sciences (HS)							
	21BEHS01	Professional English	1	0/2	3	50	50	100	2
II		Basic Sciences (BS)							
	21BESM01	Algebra and Calculus	3	1/0	3	50	50	100	4
	21BESP01/ 21BESC01	Engineering Physics*/ Engineering Chemistry	3	1/0	3	50	50	100	4
	21BESP02/ 21BESC02	Physics Practicals* / Chemistry Practicals	-	0/3	3	50	50	100	1.5
III		Core Courses Engineering Sciences (ES)							
	21BEES01/ 21BEES04	Basic Electrical and Electronics Engineering (ECE) / Programming for Problem Solving using C and Python (CSE)*	3	1/0	3	50	50	100	4
	21BEES02	Engineering Graphics (Civil)	1	0/4	3	50	50	100	3
	21BEES03/ 21BEES06	Basic Electrical Engineering Practicals (ECE)/ Programming for Problem Solving using C and Python Practicals (CSE)*	-	0/2	3	50	50	100	1
IV		Non-Credit Mandatory Courses (NMC)							
	21BEMC01	Environmental Science	3	-	2	100	-	100	Remark
	21BENSS1	NSS-I	-	-	2	100	-	100	Remark
Second Semester									
I		Humanities and Social Sciences (HS)							
	21BEHS02	Professional English Practicals	-	0/2	3	50	50	100	1
II		Basic Sciences (BS)							
	21BESM02	Laplace Transforms and Complex Variables	3	1/0	3	50	50	100	4
	21BESC01/ 21BESP01	Engineering Chemistry **/ Engineering Physics	3	1/0	3	50	50	100	4

Part	Course Code	Name of Course/ Component	Hours of Instruction/week		Scheme of Examination				
			Theory	Tutorial/ Practical	Duration of exam	CIA	CE	Total	Credits
	21BESC02/ 21BESP02	Chemistry Practicals**/ Physics Practicals	-	0/3	3	50	50	100	1.5
III		Core Courses Engineering Sciences (ES)							
	21BEES04/ 21BEES01	Programming for Problem Solving using C and Python (CSE)/ Basic Electrical and Electronics Engineering (ECE)**	3	1/0	3	50	50	100	4
	21BEES05	Workshop Practicals (Civil, ECE and FPPT)	1	0/4	3	50	50	100	3
	21BEES06/ 21BEES03	Programming for Problem Solving using C and Python Practicals (CSE)/ Basic Electrical Engineering Practicals (ECE)**	-	0/2	3	50	50	100	1
IV		Non-Credit Mandatory Courses (NCMC)							
	21BEMC02	Constitution of India	2	-	2	100	-	100	Remark
	21BENSS2	NSS-II	-	-	2	100	-	100	Remark
	21BAFU01	Fundamentals of Research	2	-	2	100	-	100	Remark
* and ** 50% of the I BE students will learn in I and II semester respectively									
Third Semester									
II		Basic Sciences (BS)							
	21BESM05	Transforms, Partial Differential Equations and Applications for Electronics Engineering	3	1/0	3	50	50	100	4
III		Core Courses Engineering Sciences (ES)							
	21BELS01	C++ and Data Structures (CSE)	2	0/2	3	50	50	100	3
		Core Courses Professional Core (PC)							
	21BELC01	Analog Electronic Circuits- I	3	-	3	50	50	100	3
	21BELC02	Digital Electronics	3	1/0	3	50	50	100	4
	21BELC03	Signals and Systems	3	1/0	3	50	50	100	4
	21BELC04	Networks and Transmission Lines	3	-	3	50	50	100	3
	21BELC05	Electron Devices and Circuits Practicals	-	0/3	3	50	50	100	1.5
21BELC06	Digital Electronics Practicals	-	0/3	3	50	50	100	1.5	
IV		Non-Credit Mandatory Courses (NCMC)							
	21BEMC03	Consumer Affairs	3	-	2	100	-	100	Remark
		Value Added Course	2	-	-	100	-	100	Remark
	21BENSS3	NSS-III	-	-	2	100	-	100	Remark

Part	Course Code	Name of Course/ Component	Hours of Instruction/week		Scheme of Examination				
			Theory	Tutorial/ Practical	Duration of exam	CI A	CE	Total	Credits
Fourth Semester									
		Basic Sciences(BS)							
II	21BESM10	Probability and Stochastic Processes	3	1/0	3	50	50	100	4
III		Core Courses Engineering Sciences (ES)							
	21BELS02	Control Systems	3	-	3	50	50	100	3
III		Core Courses Professional Core (PC)							
	21BELC07	Analog Electronic Circuits-II	4	-	3	50	50	100	4
	21BELC08	Electromagnetics and Waveguides	3	-	3	50	50	100	3
	21BELC09	Microprocessor and Microcontroller	3	1/0	3	50	50	100	4
	21BELC10	Computer Networks	3	-	3	50	50	100	3
	21BELC11	Electronic Circuits Practicals	-	0/3	3	50	50	100	1.5
	21BELC12	Microprocessor and Microcontroller Practicals	-	0/3	3	50	50	100	1.5
IV		Non-Credit Mandatory Courses (NCMC)							
	21BECS01	Communication Skills	3	-	2	100	-	100	Remark
	21BENSS4	NSS-IV	-	-	2	100	-	100	Remark
# 6 to 8 weeks Industrial Internship during summer vacation									
Fifth Semester									
I		Humanities and Social Sciences (HS)							
	21BEHS11	E- Waste Management	3	-	3	50	50	100	3
III		Core Courses Professional Core (PC)							
	21BELC13	Analog and Digital Communication	3	-	3	50	50	100	3
	21BELC14	Computer Architecture and Organization	3	-	3	50	50	100	3
	21BELC15	Antennas and Wave Propagation	3	-	3	50	50	100	3
	21BELC16	Digital Signal Processing	3	1/0	3	50	50	100	4
	21BELC17	Analog and Digital Communication Practicals	-	0/3	3	50	50	100	1.5
	21BELC18	Digital Signal Processing Practicals	-	0/3	3	50	50	100	1.5
		Professional Electives (PE)							
		Elective – I (PE1/PE2)	3	-	3	50	50	100	3
IV		Non-Credit Mandatory Courses (NCMC)							
	21BESS01	Soft Skills	3	-	2	100	-	100	Remark
	21BENSS5	NSS-V	-	-	2	100	-	100	Remark

Part	Course Code	Name of Course/ Component	Hours of Instruction/week		Scheme of Examination					
			Theory	Tutorial/ Practical	Duration of exam	CI A	CE	Total	Credits	
Sixth Semester										
I		Humanities and Social Sciences (HS)								
	21BEHS12	Professional Ethics in Engineering	3	-	3	50	50	100	3	
		Core Courses Professional Core (PC)								
III	21BELC19	VLSI Design	3	-	3	50	50	100	3	
	21BELC20	Embedded System Design and Architecture	3	-	3	50	50	100	3	
	21BELC21	Mobile and Millimeter Wave Communication	3	-	3	50	50	100	3	
	21BELC22	VLSI Design Practicals	-	0/3	3	50	50	100	1.5	
	21BELC23	Embedded System Practicals	-	0/3	3	50	50	100	1.5	
	21BELC24	Mini project	-	0/4	-	100	-	100	2	
		Professional Electives (PE)								
			Elective – II (PE1/PE2)	3	-	3	50	50	100	3
		Elective –III (PE1/PE2)	3	-	3	50	50	100	3	
IV		Non-Credit Mandatory Courses (NCMC)								
		Co- Curricular Course	-	-	-	100	-	100	Remark	
	21BENSS6	NSS-VI	-	-	2	100	-	100	Remark	
#6 to 8 weeks Industrial Internship during summer vacation										
Seventh Semester										
III		Core Courses Professional Core (PC)								
	21BELC25	Microwave Engineering and Optical Communication	3	-	3	50	50	100	3	
	21BELC26	Digital Image Processing and Computer Vision	3	-	3	50	50	100	3	
	21BELC27	Microwave Engineering and Optical Communication Practicals	-	0/3	3	50	50	100	1.5	
	21BELC28	Digital Image Processing Practicals	-	0/3	3	50	50	100	1.5	
	21BELC29	Industrial Internship #	-	-	-	100	-	100	1	
	21BELC30	Research Project Phase I	-	0/4	3	100	-	100	2	
		Professional Electives (PE)								
			Elective - IV (PE1/PE2)	3	-	3	50	50	100	3
			Elective - V (PE1/PE2) Title of MOOC (SWAYAM-NPTEL)##	3	-	-	-	100	100	3
			Elective - VI (PE1/PE2) Title of MOOC (SWAYAM-NPTEL)##	3	-	-	-	100	100	3
		Open Electives (OE)								
		21BEVO01/ 21BEOO01/ 21BEBO01/ 21BEFO01/ 21BEPO01	Open Elective - I	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	CI A	CE	Total	Credits
IV	Non-Credit Mandatory Courses (NMC)								
	21BEMC04	Disaster Management	3	-	2	100	-	100	Remark
	21BEML01	Electronics and Communication Engineering- Computer Based Test (CBT)	-	-	2	100	-	100	Remark
## Two MOOCs (12 weeks duration) through SWAYAM - NPTEL with credit transfer of 6 credits, as an alternative to two Professional Elective Courses Elective V and Elective VI in VII Semester should be completed between 3 rd and 7 th semester. Title of the MOOC to be specified after enrolment.									
Eighth Semester									
III	Core Courses Professional Core (PC)								
	21BELC31	Research Project Phase II	-	0/20	-	100	100	200	10
Total Credits									165
	21BELMC1	MOOC (Core/Non-Core)	-	-	-	-	-	-	2
One core/non-core MOOC (8 weeks duration) through SWAYAM-NPTEL to be completed with 2 credits between 3 rd and 7 th semester (without credit transfer).									

<i>Semester</i>	<i>Course Code</i>	<i>Name of Course/component</i>	<i>Hours of Instruction/ week /Course</i>	<i>Credit/ Course</i>
Part – IV Non- Credit Mandatory Courses (NCMC)				
A. Ability Enhancement Compulsory Courses (AECC)				
1	21BEMC01	Environmental Science	3	Remark
2	21BEMC02	Constitution of India	2	
2	21BAFU01	Fundamentals of Research	2	
3	21BEMC03	Consumer Affairs	3	
4	21BECS01	Communication Skills (Assertive Communication Skills & Presentation skills, Interview Skills and group discussions etc.)	3	
5	21BESS01	Soft Skills <ul style="list-style-type: none"> • Body Language, Aptitude Preparation etc. • Work Ethics • Interpersonal Relations • Adapting to the Corporate Culture • Individual Counselling & Guidance • Career Orientation Program related aptitude (Contact followed by online)	3	
7	21BEMC04	Disaster Management	3	
7	21BEML01	Electronics and Communication Engineering- Computer Based Test (CBT)	-	
B. Skill Enhancement Courses (SEC)				
3		Value Added Course (from a basket of choices offered)	40 hrs. duration	Remark
6		Co-Curricular Course	Varied duration	
C. Extra Curricular Courses (ECC)				
1-6	21BENCC1-6/ 21BENSS1-6/ 21BESPO1-6	NCC/NSS/Sports (Representing the Institute)	-	Remark

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 MOOCs (12 weeks duration) to be completed through SWAYAM – NPTEL as an alternative to two Professional Electives, Elective V & Elective VI in the seventh semester. Additionally, one core/non-core MOOC-NPTEL course to be completed with 2 credits (8 weeks duration) between 3rd and 7th Semester (without credit transfer).
4. # 6 to 8 weeks Industrial Internship during 4th and/or 6th semester during summer vacation.

Other courses offered by the Department:

Value Added Course

<i>Part</i>	<i>Course Code</i>	<i>Name of Course/component</i>
IV	21BELV01	Embedded System for Beginners

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

<i>Part</i>	<i>Semester</i>	<i>Course Code</i>	<i>Name of Course/component</i>
III	V Semester Elective I	21BELE01	Advanced Digital System Design
		21BELE02	Electronic Measurement and Instrumentation
		21BELE03	Virtual Instrumentation
	VI Semester Elective II	21BELE04	Advanced Digital Communication
		21BELE05	Advanced Data Communication
		21BELE06	Advanced Digital Signal Processing
	VI Semester Elective III	21BELE07	Smart Antennas and MIMO
		21BELE08	Soft Computing Techniques
		21BELE09	Electronic Product Design
	VII Semester Elective IV	21BELE10	Automotive Electronics
		21BELE11	Nano and Flexible Electronics
		21BELE12	RF MEMS
	VII Semester Elective V	21BELE13	MOOC (12 Weeks Course in SWAYAM- NPTEL)
	VII Semester Elective VI	21BELE14	MOOC (12 Weeks Course in SWAYAM- NPTEL)

List of Professional Electives (PE2) IoT Domain

<i>Part</i>	<i>Semester</i>	<i>Course Code</i>	<i>Name of Course/component</i>
III	V Semester Elective I	21BELE21	Fundamentals of IoT
		21BELE22	Operating Systems
		21BELE23	Programming Languages
	VI Semester Elective II	21BELE24	Printed and Wearable Electronics
		21BELE25	Embedded OS and RTOS
		21BELE26	Wireless Sensor Networks
	VI Semester Elective III	21BELE27	IoT Architecture and Standards
		21BELE28	Sensors and Actuators
		21BELE29	5G Communication in IoT
	VII Semester Elective IV	21BELE30	Industry 4.0 and Industrial IoT
		21BELE31	Data Mining
		21BELE32	Queueing Theory
	VII Semester Elective V	21BELE33	MOOC (12 Weeks Course in SWAYAM- NPTEL)
	VII Semester Elective VI	21BELE34	MOOC (12 Weeks Course in SWAYAM- NPTEL)

Open Elective

<i>Part</i>	<i>Course Code</i>	<i>Name of Course</i>
III	21BELO01	Concepts and Servicing of Home Appliances

Professional English-1
(Common to all branches)

Semester I
21BEHS01

Hours of instruction/week: 1T+2P
No. of credits: 2

Objective:

CLO 1: To familiarize students to corporate communication skills

Unit I Language through Reading **9**

Skimming, scanning, predicting the content of a given passage, identifying the lexical and contextual meanings, note making (guided & unguided) cloze reading, drawing inferences, separating facts from opinions.

Unit II Focus on Language **9**

Word formation with prefixes and suffixes, synonyms and antonyms, Impersonal passive voice, Tenses, use of prepositions, 'if clauses', use of words as nouns and verbs, subject, verb, agreement, Editing, British and American English.

Unit III Language through Practice **9**

Resume writing, writing instructions and recommendations, preparing checklists, classifying the data, analyzing / interpreting the data, Paragraph writing, Formal letters, writing to officials (leave letter, seeking permission for practical training, asking for Certificates, testimonials), unseen comprehension, creative writing, Framing Agendas, Minutes of the meeting.

Unit IV Oral Practice (Lab Sessions) **9**

Pronunciation Techniques:

Phonetics, Stress, Primary and Secondary stress, Neutral Accent, Rising and Falling Tone, Voice Modulation.

Public Speaking Skills:

Compeering, introducing a guest to the audience, welcome address, proposing a vote of thanks.

Unit V (Lab Sessions) **9**

Justifying and Summarizing Skills:

Emphasizing a point, discussing the pros and cons, focusing on reasons, Summarizing briefly and concisely

Designing an Advertisement:

Interpreting advertisements, Slogan/caption writing, creating one's own advertisement for a product.

Total Hours: 45

References:

1. *Aysha Viswamohan (2008). English for Technical Communication.* Tata McGraw-Hill Publishing Co Ltd, New Delhi.
2. *Dr. S. Sumant, English for Engineers(2005).* Tata McGraw Hill Publishing Co Ltd, New Delhi.
3. *M. Ashref Rizvi (2005). Effective Technical Communication.* Tata McGraw Hill Publishing Co Ltd, New Delhi.
4. *Raymond V Lesikar & Marie E. Flatley(2005). Basic Business Communication.* Tenth Ed. Tata McGraw Hill Publishing Co. Ltd, New Delhi.

Expected Outcomes

On completion of the course students will be able to:

CO 1: Create organized academic and professional writing

CO 2: Develop aural competency and oral fluency of learners

CO 3: Achieve proficiency in the effective use of language in various authentic career, related situations.

CO PO Matrix

Program Outcome												
Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	M	M	H	-	-
CO2	-	-	-	-	-	-	-	L	H	M	-	-
CO3	-	-	-	-	-	-	-	H	M	L	-	-

Algebra and Calculus

(Common to all branches)

Semester I
21BESM01

Hours of Instruction/ week: 3T+1Tu
No.of Credits : 4

Objectives:

CLO1 Develop skills in processing matrices and applications of differential calculus

CLO2 Enrich knowledge in solving problems in multiple integrals and ordinary differential equation

CLO3 Gain practice in implementing algorithms and to use software tools

UNIT I EIGENVALUES AND EIGENVECTORS

12

Characteristic equation of matrix - Eigenvalues and Eigenvectors of a real matrix- Properties of Eigenvalues and Eigenvectors -Cayley Hamilton theorem- Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT II GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS

12

Curvature- Cartesian and polar co-ordinates - Centre and radius of curvature - Circle of curvature-Involute and Evolute - Envelopes of family of curves- Maxima and minima- Constrained maxima and minima -Jacobians.

UNIT III 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 IV ORDINARY DIFFERENTIAL EQUATIONS

12

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.

UNIT V MATHEMATICAL SOLUTIONS USING SOFTWARE TOOLS

12

Arithmetic Operations Commands - Elementary Math Built-in functions – Arrays -Ordinary differential equations - Multiple Integrals(Unit V is only for gaining knowledge in software applications and not included in theory exams)

Total hours –60

Text Books:

1. *T.Veerarajan (2016), Engineering Mathematics (for semester I and II)*, updated 2ndEdition, Tata McGraw Hill Publishing Co.Ltd, New Delhi.
2. *P.Kandaswamy, K.Thilagavathy and K.Gunavathy (2014), Engineering Mathematics, Volume I*, 10thRevised Edition, S. Chand & Co, New Delhi.

References:

1. *E.Kreyszig (2014), Advanced Engineering Mathematics*, 8thEdition, John Wiley and Sons (Asia) Ltd, Singapore.
2. *Dennis G. Zill and Michael R.Cullen(2012),Advanced Engineering Mathematics*,2nd edition, CBS Publishers.
3. *Srimanta Pal and Subhodh C Bhunia(2012), Engineering Mathematics*, 9thEdition,John Wiley and Sons.
4. *Dr. B. S. Grewal (2014), Higher Engineering Mathematics*, 43rd Edition, Khanna Publishers, New Delhi.
5. *Jain R.K. and Iyengar S.R.K. (2007), Advanced Engineering Mathematics*, 3rdEdition,Narosa Publications, New Delhi.
6. Open Source Software tools.

Course Outcomes:

On completion of course the students will be able to

CO1: Apply the concepts of Algebra and calculus in engineering fields like computer science, communication, food technology etc.

CO2: Develop mathematical models to interpret and solve engineering problems

CO3: Appreciate the need of software tools to solve higher order linear ordinary integral and differential equations used in real world problems

CO/PO Matrix

POs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CO1	H	H	M	-	-	-	-	-	-	-	-	M
CO2	H	H	M	-	-	-	-	-	-	-	-	M
CO3	H	H	M	-	L	-	-	-	-	-	-	M

Engineering Physics
(Common to all branches)

Semester I/ II
21BESP01

Hours of instruction/week: 3T+1Tu
No. of credits: 4

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

Unit I Ultrasonics& Acoustics

12

Introduction, Magnetostriction effect, Production of ultrasonic waves: Magnetostriction generator, Inverse piezoelectric effect, Piezoelectric generator, Detection of ultrasonic waves, Properties, Cavitation soldering and cleaning, Ultrasonic Doppler Blood flow meter

Classification of sound, characteristics of musical sound, Weber- Fechner law, Absorption coefficient and its determination, Factors affecting acoustics of building and their remedies.

Unit II Lasers & Fiber optics

12

Principle of spontaneous and stimulated emission, Einstein theory of stimulated emission, Population inversion, Pumping mechanism, Types of Lasers, CO₂, Nd-YAG and Semiconductor laser, Applications: welding, heat treatment, cutting and holography.

Principle of fiber optics, Preparation, Crucible-crucible technique, Classification based on materials, refractive index profile, Applications: Fiber optic communication, Temperature sensor and Endoscope.

Unit III Crystal physics

12

Single crystalline, polycrystalline and amorphous materials – single crystals, unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distance - coordination number and packing factor for SC, BCC, FCC and HCP structures- crystal imperfections: point defects, line defect ,growth of single crystals: Czochralski growth technique.

Unit IV Quantum physics

12

Introduction to Quantum theory, Dual nature of matter and radiation, de Broglie wave length, Uncertainty principle, Schrödinger wave equation, Particle in one dimensional box, Electron microscope, Scanning electron microscope (SEM), Scanning Transmission Electron Microscope (STEM).

Unit V Vacuum & Nano science

12

Importance of vacuum in industries, Pumping speed and throughput, Types of pumps, Working principle and construction of Rotary pump, Diffusion pump, Measurement of vacuum using Pirani and Penning Gauges.

Dimensionality and size dependence, Fabrication methods: Top down process (Lithographic process) and Bottom up process (Physical vapour deposition) Carbon Nanotubes (CNT), Types and Properties, Fabrication of CNT -Laser ablation method, Applications: CNT field effect transistor, Fuel cells, Organic light emitting diode (OLED).

Total Hours : 60

References

1. *Bhattacharya D.K&T.Poonam(2015). Engineering Physics*, Oxford University Press,
2. *M.N Avadhanulu , P G Kshirsagar & TVS Arun Murthy (2018) A Textbook of Engineering Physics*, S. Chand Publishing.
3. *V Rajendran* Engineering Physics, Tata Mcgraw Hill Publishing Co Ltd
4. *S.O. Pillai (2011).Solid State Physics New Age International (P) Limited, Publishers*
5. *S. Jaya Kumar (2009). Materials Science. R.K. Publishers, Coimbatore*
6. *G. SenthilKumar(2011). Engineering Physics. Chennai Revised Edition. VRP Publisher*
7. *S. Jayakumar (2007).Engineering Physics First Edition, RK Publishers, Coimbatore*

Outcomes

On completion of the course students will able to

CO1: Identify the basic concepts of Physics applied in Engineering.

CO2: Discuss the theory and demonstrate the methods involved in Engineering Physics.

CO3: Apply the theoretical ideas of various processes and techniques of physics in Engineering and Technology.

CO/PO Matrix

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	H	M	M	-	-	M	L	-	M	-	-	L
CO2	H	M	-	-	-	M	L	-	M	-	-	L
CO3	H	M	M	-	-	M	L	-	M	-	-	L

Physics Practicals
(Common to all branches)

Semester I/ II
21BESP02

Hours of Instruction/week:3P
No. of credits: 1.5

Objective

CLO1: To impart experimental skills on potentially important experiments needed for Engineering.

List of Experiments (Any 10)

1. LASER- Wavelength & Particle size determination
2. Ultrasonic interferometer-Determination of compressibility of a liquidS
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-Bandgap 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

Outcomes

On completion of the course students will be able to

CO1:Conduct experiments and interpret the results.

CO2: Verify the knowledge gained in theory with practical results.

CO/PO Matrix

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	H	H	-	M		M	-	-	M	-	-	M
CO2	H	H	-	M	-	M	-	-	M	-	-	M

Basic Electrical and Electronics Engineering

Semester I
21BEES01
Objective:

Hour of Instruction/week: 3L+1Tu
No. of credits: 4

- CLO1: To provide a comprehensive idea for engineering students about AC and DC circuit analysis, working principles of basic machines in electrical engineering and their applications in various fields.
- CLO2: To understand the working principle of electronic devices and circuits.

Unit I Basics of Circuit Analysis **12**

Ohm's Law- Kirchoff's Laws- DC circuits-AC Circuits (in series and parallel)- Mesh and Nodal analysis using Matrix method, Thevenin's and Norton's theorems- Superposition theorem- Reciprocity theorem - Maximum power transfer theorem.

Unit II Introduction to Single and three phases **12**

Single phase and three phase with applications, three phase balanced /unbalanced loads – current and voltage relationship in star/delta connection – phasor diagrams of voltage and current – power and power factor measurements in three phase circuits - Transient response of RL, RC and RLC circuits to DC excitation - Three phase power- measurement by two wattmeter methods.

Unit III Transformers **12**

Principle of operation, Mutual coupling, construction, EMF equation, power losses, efficiency, Transformers and their functions, OC and SC equivalent Circuits, Ideal and practical transformer, losses in transformers, Introduction to auto transformers, applications.

Unit IV Basics of Electronics **12**

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-Rectifier Circuits - Working principle and characteristics – Wave shaping examples- Introduction to BJT, JFET and MOSFET (Construction, working and characteristics).

Unit V Electrical Machines **12**

Protection and Devices: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing, Types of Batteries DC Machine & Induction Motor: DC Generator, DC Motor - Construction, working principle, EMF equation and its types (qualitative treatment only). Single Phase Induction Motor- Construction and working (qualitative treatment only).

Total Hours: 60

Reference Books:

1. *R.K.Mehta & A.K.Mal* “*Problems and Solution of Electrical Circuit Analysis*” CBS Publishers, 2015
2. *D.P.Kothari and I.J.Nagrath*, “*Basic Electrical Engineering*”, Tata McGraw Hill, 2010.
3. *E.Hughes*, “*Electrical and Electronics Technology*”, Pearson, 2010.
4. *Joseph Edminister and Mahmood Nahri*, “*Electric Circuits*”, fifth Edition, Tata McGraw Hill New Delhi, 2008.
5. *V.K.Mehta, Rohit Mehta*, “*Principles of Electrical Machines*”, S.Chand & company Ltd., Reprint 2006.
6. *John Bird*, “*Electrical Circuit theory and technology*”, Routledge; 5th edition, 2013
7. *Thomas L. Floyd*, “*Electronic Devices*”, 10th Edition, Pearson Education, 2018.

Course Outcomes:

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

CO1: Comprehend the basic concepts of electric and magnetic circuits

CO2: Differentiate properties and Analyse AC as well as DC circuits and various machines,

CO3: Understand the working principle of electronic devices such as diode, Zener diode, characteristics and working of current controlled and voltage-controlled devices

CO/PO Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	L									L
CO2	H	H	L									L
CO3	H	L	L			M	M					L

Programming for Problem Solving using C and Python

Semester I/ II

Hours of instruction/week: 3T+1Tu

21BEES04

No. of Credits: 4

Objectives:

CLO1: Understand the basic knowledge in programming concepts and problem solving using C.

CLO2: Learn core Python scripting elements such as variables and flow control structures and develop simple applications.

Unit- I C Programming Fundamentals 12

Introduction to C programming – Fundamentals – Structure of a C program – Character set- Keywords- Data types and sizes - Constants- Variables – Expressions - Operators –Control statements - if - else statement- nested if statement- switch case – Looping Statements - while- do-while- for - nested control structures - break- continue- goto statement – Implementation of simple C programs on Control Structures.

Unit- II Arrays and Strings 12

Arrays: Introduction - Initialization – Declaration – One Dimensional and Two Dimensional Arrays. Strings: String Operations – String Arrays - Variable length arrays- Implementation of Concepts on Arrays and String handling.

Unit -III Functions and Pointers 12

Functions: Prototypes and Functions–Declaring- defining and accessing functions–Parameter passing methods –Recursion–Storage classes–auto- extern- static and register–Library functions. Pointers: Pointer concept–Declaration–Accessing variable through pointer–Initializing pointer variable–Pointers and Functions–Pointers and Arrays - Implementation of Concepts on Functions and Pointers- Structures and Union.

Unit-IV Fundamentals of Python Programming 12

Introduction : History - Features - Setting up path - Working with Python - Basic syntax - Variables and Data types - Operators - Conditional- Looping –Control statements. String Manipulation: Accessing Strings - Operations and String slices. Functions: Definition - Calling a Function - Types - Arguments - Global and Local variable.

Unit-V Core Python Programming 12

Lists: Introduction - Accessing list - Operations and Methods. Tuples: Accessing Tuples - Operations - Working - Functions and Methods. Dictionaries: Accessing values in Dictionaries - Properties - Functions. Modules: Importing Module - Packages - Compositions. Exception Handling: Exception and Exception handling.

Total hours: 60

References:

1. PradipDey- ManasGhosh (2013). *Computer Fundamentals and Programming in C*. Second Edition. Oxford University Press.

2. *Yashavant P. Kanetkar (2011).Let Us C.* BPB Publications.
3. *Allen B. Downey (2016).Think Python: How to Think Like a Computer Scientist.* 2nd edition.O'Reilly Publishers.
4. *Guido van Rossum and Fred L. Drake Jr (2011). An Introduction to Python – Revised and updated for Python 3.2.* Network Theory Ltd.
5. *Ashok N. Kamthane (2007). Computer Programming.*Pearson Education.
6. *Kernighan,B.W and Ritchie,D.M (2006). The C Programming language.*Second Edition.Pearson Education.
7. *Byron S Gottfried and Jitendar Kumar Chhabra (2011).Programming with C.*Third Edition.Tata McGraw Hill Publishing Company.

Course Outcomes:

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

CO1:Describe and use the data types, expressions, functions, control statements, strings in C and Python programming.

CO2:Write user defined functions and implement different Operations on arrays, strings, pointers and classes in python.

CO3:Identify and use suitable C and python programs to solve real life problems.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	L	L	M	L	M	–	–	–	L	–	–	–
CO2	L	L	M	L	M	–	–	–	L	–	–	–
CO3	L	M	M	L	M	–	–	–	L	–	–	–

Eleventh edition. PrenticeHall of India Pvt., Ltd.,

6. Gopalakrishnan K.R (2007). Engineering Drawing (Vol.I& II).Subhass Publications.
7. Bertoline and Wiebe (2007). Fundamentals of graphics Communication. Third edition.
8. DhananjayA.Jolhe (2008). Engineering Drawing with an introduction to AutoCAD. Tata McGraw Hill Publishing Company Limited.

Course Outcomes:

CO1: To draw orthographic projection of one dimensional, two dimensional and 3 dimensional objects.

CO2: To prepare isometric and perspective sections of simple solids

CO3: To demonstrate basic skills in computer aided drafting.

CO- PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	H								L	H			M	
CO2	H								M	H				
CO3	H				H					H			L	

Basic Electrical Engineering Practicals

Semester I
21BEES03

Hours of Instruction/week:2P
No.ofcredits:1

Objective:

CLO1:To make the students learn and use the basic electrical concepts in various practical applications and machines.

List of Experiments:

Introduction and use of measuring instruments–voltmeter, ammeter, multi-meter, oscilloscope, resistors, capacitors and inductors.

1. Design a resistive circuit to derive the specified load voltage and load current from a DC power source.
2. Verification of Kirchhoff's laws.
3. Build and test the voltage across and the current through any element using appropriate circuit analysis techniques.
4. Verify a circuit topology having star/delta connected network.
5. Design an RL/RC circuit for a given time constant, determine its current/voltage response and analyze the step response and the source free response of your circuit with initial conditions.
6. Design a home wiring circuit with R, RL load and two-way switch.
7. Power measurements in three phase system by two wattmeter method.
8. Determination of efficiency of single-phase transformer by load test.
9. Determination of efficiency of single-phase induction motor by Load test.
10. Load test and No-load test on DC motor.
11. Speed control of DC shunt motor.

Total Hours: 30

Course Outcomes:

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

CO1: Analyze AC and DC circuits and verify networks theorem

CO2: Design and demonstrate wiring for various loads.

CO3:Test transformers and electrical machines

CO/PO Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	L					L			L
CO2	H	H	L	L					L			L
CO3	H	H	L	H		L			L	L		L

Programming for Problem Solving using C and Python Practicals

Semester I/II
21BEES06

Hours of instruction/week: 2P
No. of Credits: 1

Objective:

CLO:To understand and gain knowledge on the basic concepts in C and Python Programming languages.

List of Experiments:

C Programs

1. Programs using conditional operator and if statement
2. Programs using Switch Case Statements
3. Programs using for- while and do while loops
4. Programs using Arrays
5. Programs using Functions and Recursive Functions
6. Programs using Structures
7. Programs using Pointers
8. Programs using Files

Python Programs

1. Basic Python programs for reading input from console.
2. Programs using built-in data types – Numeric, Sequences (String, List, Tuple), Set and Dictionary Operations and type conversions
3. Programs using Looping statements.
4. Programs using the Decision statements
5. Programs for math operations and random number generation
6. Programs using user-defined functions with different types of function arguments
7. Programs for Class declaration and Object creation
8. Programs for File manipulations.

Total Hours: 30

References:

1. *Pradip Dey- Manas Ghosh (2013). Computer Fundamentals and Programming in C.* Second Edition. Oxford University Press.
2. *Yashavant P. Kanetkar (2011). Let Us C.* BPB Publications.
3. *Allen B. Downey (2016). Think Python: How to Think Like a Computer Scientist.* 2nd edition. O'Reilly Publishers.
4. *Guido van Rossum and Fred L. Drake Jr (2011). An Introduction to Python – Revised and updated for Python 3.2.* Network Theory Ltd.
5. *Ashok N. Kamthane (2007). Computer Programming.* Pearson Education.
6. *Kernighan, B.W and Ritchie, D.M (2006). The C Programming language.* Second Edition. Pearson Education.
7. *Byron S Gottfried and Jitendar Kumar Chhabra (2011). Programming with C.* Third Edition. Tata McGraw Hill Publishing Company.

Course Outcomes:

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

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

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

CO3: Analyze a problem and use appropriate language in C and python programs to solve it.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	M	H	M	L	L	-	-	-	-	M	M	M
CO2	L	M	H	M	L	-	-	-	-	M	M	M
CO3	M	M	M	L	L	-	-	-	-	M	M	M

**Environmental Science
(Common to all branches)**

**Semester I
21BEMC01**

Hours of Instruction /week: 3T

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.

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 .

Outcomes:

On completion of the course students will be able to:

CO1: Correlate the complex relationship between natural environment and human activities.

CO2: Predict the consequences of human actions on the web of life, global economy and quality of life.

CO3: Identify suitable measures to solve environmental problems.

CO/PO Matrix

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	M	-	-	-	M	H	M	L	-	-	M
CO2	L	M	-	-	-	H	H	M	L	-	-	M
CO3	L	M	-	-	-	H	H	M	L	-	-	M

Professional English Practicals
(Common to all branches)

Semester II
21BEHS02

Hours of instruction/week:0T+ 2P
No. of credit: 1

Objective:

CLO 1: To provide hands-on aural, oral, reading and writing practices to students

Exercises:

I Group Discussion **4**
GD strategies, initiating a discussion, persuasion skills, body language, ways of interrupting (non-offending), summarizing and concluding.

II Interview Skills **4**
Introducing oneself, listing one's aspirations and goals, systematically expressing one's achievement (academic as well as professional), listening keenly and gently manipulating the interviewer, e mail etiquette.

III Presentation Skills **5**
Business and technical presentation, technical articles (for journals and conferences), business etiquette.

IV Active Listening Practices **4**
Speech decoding, comprehending, types of conversation, formal and informal, listening to academic, business and technical speeches.

V Online Grammar Exercises **4**
Editing the passage, cloze exercises, jumbled sentences, tag question, usage of tenses, phrasal verbs, sentence patterns.

VI Vocabulary Enrichment **4**
Word formation, technical jargon, words often confused and misused, homophones.

VII Book Review **5**
Reading inspiring articles, inferring meanings, reading between the lines and beyond the lines, understanding implicit and explicit ideas.

Total Hours : 30

References :

1. *Aysha Viswamohan (2008). English for Technical Communication.* Tata McGraw Hill Publishing Co. Ltd, New Delhi.
2. *M. Ashref Rizvi (2005). Effective Technical Communication.* Tata McGraw Hill Publishing Co. Ltd, New Delhi.
3. *Dr.K.Devadoss and P.Malathi (2008).Customize Yourself to Corporate Life.* Inder Publications, Coimbatore.

Outcomes

On completion of the course students will be able to:

CO 1: Analyze and acquire listening and speaking skills in both formal and informal contexts.

CO 2: Acquire English language skills at their own pace by using language lab components.

CO 3: Communicate their thoughts, opinions and ideas freely and naturally.

CO PO Matrix

Program Outcome												
Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	M	M	H	-	-
CO2	-	-	-	-	-	-	-	L	H	M	-	-
CO3	-	-	-	-	-	-	-	H	M	L	-	-

Laplace Transforms and Complex variables

(Common to all branches)

Semester II
21BESM02

Hours of Instruction/ week: 3T+1Tu
No. of Credits: 4

Objectives:

CLO1: To enhance knowledge in Laplace transforms, vector calculus and its applications.

CLO2: To understand the concepts of complex integration and contour integration.

CLO3: To gain knowledge in creating and working with arrays and to explore the built – in functions for vector, matrix operations and integration.

UNIT I LAPLACE TRANSFORM

12

Laplace Transform, Definition and Sufficient conditions, Transforms of functions, properties of Laplace Transforms, Inverse transforms, Derivatives and integrals of transforms, Transforms of derivatives and integrals, Convolution theorem, Transform of periodic functions, Application to solution of linear ordinary differential equations up to second order with constant coefficients.

UNIT II 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 , $\frac{1}{z}$

UNIT III 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 IV 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.

UNIT V MATHEMATICAL SOLUTIONS USING SOFTWARE TOOLS

12

Scripts and Functions, Software tools applied to operation with Vectors, Arrays and Complex Integrations. (Unit V is only for gaining knowledge in software applications and not included in theory exams)

Total hours –60

Text Books:

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.

References:

1. *E.Kreyszig (2014), Advanced Engineering Mathematics*, 8th Edition, John Wiley and Sons (Asia) Ltd, Singapore.
2. *Dennis G. Zill and Michael R.Cullen (2012), Advanced Engineering Mathematics*, 2nd Edition, CBS Publishers.

3. *Srimanta Pal and Subhodh C Bhunia (2012), Engineering Mathematics, 9th Edition, John Wiley and Sons.*
4. *Dr. B. S. Grewal (2014), Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, New Delhi.*
5. *Jain R.K. and Iyengar S.R.K. (2007), Advanced Engineering Mathematics, 3rd Edition, Narosa Publications, New Delhi.*
6. *Sastry, S.S (2014), Engineering Mathematics'', Vol. I & II, 4th Edition, PHI Learning Pvt. Ltd, New Delhi,.*
7. Open Source Software tools.

Course Outcomes:

On completion of course the students will be able to

CO1: Recognise the need of Laplace transform techniques, Complex integrals and Vector calculus in engineering fields like computer science, biomedical, communication etc.

CO2: Apply the knowledge of Laplace transforms and Complex variables in solving complex engineering problems

CO3: Assess complex variables and evaluate complex integrals that arise in engineering fields

CO/PO Matrix

POs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
CO1	H	H	M	-	-	-	-	-	-	-	-	M
CO2	H	H	M	-	-	-	-	-	-	-	-	M
CO3	H	H	M	-	L	-	-	-	-	-	-	M

Engineering Chemistry
(Common to all branches)

Semester I/ II
21BESC01

Hours of Instruction/week: 3T+1Tu
No. of credits: 4

Objective:

CLO 1: 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.

Unit I Water Technology **12**

Characteristics: Alkalinity, types of alkalinity and determination. Hardness: Types and estimation by EDTA method (problems). Boiler feed water, requirements, and disadvantages of using hard water in boilers. Internal conditioning: Phosphate, calgon and carbonate conditioning. External conditioning: Demineralization process. Domestic water treatment: Disinfection methods (Chlorination, ozonation, UV treatment). Desalination: Reverse osmosis.

Unit II Electrochemistry and corrosion **12**

Electrochemical cells: Electrode potential, Nernst equation (problems). Reference electrodes: Calomel electrode, glass electrode and measurement of pH, EMF, electrochemical series and its significance. 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 Engineering Materials **12**

Refractory, classification, acidic, basic, and neutral refractory, Properties (refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling), manufacture of alumina, magnesite and zirconia bricks, Adhesives – adhesive action – development of adhesive strength – physical and chemical factors influencing adhesive action – bonding process of adhesives – phenol formaldehyde resins, polyurethane, epoxy resins and urea formaldehyde. Lubricants, properties, viscosity index, flash and fire points, cloud and pour points, oiliness, aniline point, solid lubricants, graphite and molybdenum sulphide, semisolid lubricants, greases.

Unit IV Polymer Chemistry **12**

Introduction: Functionality-degree of polymerization. Classification of polymers- Natural and synthetic, thermoplastic and thermosetting. Types and mechanism of polymerization: addition (free radical, cationic, anionic), condensation and copolymerization. Properties of polymers: T_g, tacticity, molecular weight-weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension. Conducting polymers, types, mechanism of conduction and Applications.

Unit V Photochemistry and Spectroscopy **12**

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

Total Hours: 60

REFERENCES:

1. **Jain P. C. & Monika Jain., “Engineering Chemistry”**, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, ISBN 13: 9788187433170, 2015.
2. **Vairam S., Suba Ramesh., “Engineering Chemistry”**, Wiley India Pvt Ltd., New Delhi.,ISBN 13: 9788126544752, 2013.
3. **Shashi Chawla.,“A Text Book of Engineering Chemistry”**, Dhanpat Rai & Co Pvt. Ltd. 3rd Edition, 10thReprint 2013
4. **Dara S.S.,Umare S.S., ‘Engineering Chemistry’ , 12th edition,** S.Chand&CompanyPvt.Ltd,NewDelhi.,ISBN : 81-219-0359-9, 2010
5. **Palanna O.G,“Engineering Chemistry”**, 2nd Edition, McGraw-Hill Education (India) Pvt. Ltd.,Chennai,ISBN:9789352605774, 2017
6. **Kannan P., Ravikrishnan A., “Engineering Chemistry”**, Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai, 2014.

Outcomes:

Upon completion of the course, the students will be able to

CO1: Identify chemistry principles related to engineering concepts.

CO2: Analyse scientifically various chemistry related problems in engineering field based on theoretical concepts, experimental procedures and mechanism.

CO3: Predict potential applications of chemical principles and knowledge acquired in order to become good engineers and innovators

CO/PO Matrix

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	-	M	L	-	-	-	-	-
CO2	L	H	-	M	-	L	L	-	-	-	-	-
CO3	L	-	H	-	-	M	M	-	-	-	-	-

Chemistry Practicals
(Common to all branches)

Semester I/II
21BESC02

Hours of Instruction/week:3P
No. of credits: 1.5

Objective

CLO 1: To impart experimental skills and hands on experience in the use of analytical equipment needed for engineering applications.

List of Experiments

1. Determination of total hardness of water by EDTA method.
2. Determination of DO content by Winkler's method.
3. Determination of alkalinity in a water sample.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of concentration of a coloured solution using colorimeter

6. pHmetry

To find out the strength of given hydrochloric acid by sodium hydroxide.

7. Conductometry

- a. Estimation of strength of acids in a mixture of acids.
- b. Estimation of Barium Chloride using Sodium Sulphate.

8. Potentiometry

Estimation of ferrous ion in the given solution.

9. Viscometry

Determination of molecular weight of a polymer

10. Corrosion Experiment

Weight Loss method.

11. Spectrophotometry

Estimation of iron content of water sample

(Any ten experiments)

Outcomes:

Upon completion of the course, the students will be able to

CO1 : Acquire skills in measuring, recording and analysing the results.

CO2 : Assess the quality of water through different tests.

CO3 : Develop skills in handling analytical instruments.

CO/PO Matrix

Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	H	-	L	-	L	-	-	-	-
CO2	H	H	-	H	-	H	M	-	-	-	-	L
CO3	H	H	-	H	-	M	-	-	-	-	-	-

Workshop Practicals

Semester II
21BEES05

Hours of Instruction/Week: 1T + 4P
No. of Credits: 3

Course Learning Objectives:

CLO1: The course caters the needs of the practical application and to help in basic learning skills in Civil Engineering, Mechanical Engineering and Electronics Engineering.

PART A (CE)

PLUMBING WORK:

1. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
2. Preparing plumbing line sketches for household.
3. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:

1. Sawing, 2. Planning and 3. Making joints like Lap Joint and T-Joint

WOOD WORK STUDY:

1. Studying joints in door panels and wooden furniture

PART B (ME)

1. Simple turning and facing operations using Lathe
2. Knurling and Grooving operations using Lathe
3. Preparation of square butt joint in Arc welding
4. Preparation of T-Joint using Arc Welding
5. Preparation of Lap Joint using Arc Welding

PART C (ECE)

1. Soldering simple electronic circuits
2. V-I Characteristics of PN Junction Diode
3. V-I Characteristics of Zener Diode
4. Design and verify the characteristics of Half and Full Wave Rectifier
5. Household wiring – series and parallel connections with two switches
6. Stair case light wiring

Total Hours: 45

Examination Pattern:

The Examination is to be conducted for both parts AB (OR) parts AC (OR) parts BC allotting 1.5 hours for each part.

Course Outcomes:

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

- CO1:** Identify pipe fitting, prepare plumbing line sketch connect pipes of different materials in plumbing works and identify various joints and components in wooden doors and furniture's.

CO2: Operate lathe for various operations and prepare butt, T, Lap joints in Arc welding

CO3: Understand basic connections of wiring, and verify the characteristics of PN junction, Zener Diode and rectifiers.

CO – PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H				M	M			M	M		H		
CO2	H	H		H		H	M					L	H	H
CO3	H	L			M				M					

Constitution of India
(Common to all branches)

Semester II

Hours of Instruction/week: 2 T

21BEMC02

Objective:

CLO 1: To know about making of Indian constitution, Rights & Duties, Organs of Governance, Local Administration, and Election Commission

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, CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPanchayat: Position and role Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

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: 45

References:

1. *The Constitution of India, 1950 (Bare Act)*, Government Publication.
2. *Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution*, 1st Edition, 2015.
3. *M. P. Jain, Indian Constitution Law*, 7th Edn., Lexis Nexis, 2014.
4. *D.D. Basu, Introduction to the Constitution of India*, Lexis Nexis, 2015.

Outcomes

On completion of the course students will be able to:

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

CO2: Appreciate and discuss the basic components of Indian constitution, Constitutional rights and duties and various Organs of Governance

CO3: Participate in democratic processes

CO PO Matrix

Program outcome												
Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	L	L	-	-	-	-
CO2	-	-	-	-	-	-	M	M	-	-	-	-
CO3	-	-	-	-	-	-	L	H	-	-	-	-

Fundamentals of Research

Semester II

Hours of instruction/week: 2

21BAFU01

No. of credits: 2

Objectives

To introduce the importance of research.

To impart knowledge on the methods of data collection and analysis

To give basic foundation of statistics.

To introduce the skill of report writing

UNIT I Introduction to Research 5

Definition – Significance of Research – Types of Research – Scope of Research – Defining the research problem – Steps in Research – importance of research problem – Research Objectives – Research Protocol – outcomes of research – Understanding concepts, constructs, variables.

UNIT II Tools for Collection of Data 6

Methods of data collection – Primary and Secondary data collection methods, qualitative methods of data collection and survey methods of data collection-Most popular methods: Direct observation, Experiments and Survey-Population and sampling – Types of sampling.

UNIT III Statistical Methods 5

Basics of data analysis - Measurement Scales, Sources of error in measurement. Measures of central tendency (Mean, Median, Mode), Measures of dispersion (Range, Mean Deviation, Standard Deviation) - Diagrammatic and Graphical representation of Data.

UNIT IV Inferential statistics 5

Types of hypothesis- Testing of Hypothesis - Type I and Type II error- Testing the difference between means (Z & t-test), ANOVA and Chi square test (basics only)

UNIT 5 Report Writing 6

Report generation –Report writing - Bibliography – Importance of Research Ethics and Integrity- Misconduct in research and consequences of misconduct

Practical session 3

Identifying a problem and using appropriate statistical tools

Text Book:

1. Kothari C. R (2016)., Research Methodology, Sultan Chand publications, New Delhi.

Reference Books:

- 1. Krishnaswami O.R, Ranganatham M (2016), *Methodology of Research in Social science*, Himalaya Publishing House, Delhi.**
- 2. Paneerselvam. R (2016), *Research methodology*, PHI learning, New Delhi.**
- 3. Deepak Chawla and Neena Sodhi (2016), *Research Methodology*, Vikas Publishing House, New Delhi.**
- 4. Gupta, S.P. (2007), *Statistical Methods*, Sultan Chand & Son Publications, New Delhi.**

Course Outcomes:

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

CO1: Identify the need for a function to approximate as an infinite series to represent discontinuous function which occurs in signal processing, electrical circuitsetc.

CO2: Recognise the need of various transforms and partial differential equations to solve complex problems in engineering fields like biomedical, communication etc.

CO3: Formulate mathematical models to analyse complex engineering problems

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M									M
CO2	H	H	M									M
CO3	H	H	M									M

2. *M.A.Weiss, “Data Structures and Algorithm Analysis in C++”, Fourth Edition, Pearson Education Asia, 2014.*
3. *Dinesh P. Mehta, SartajSahni, “Handbook of Data Structures and Applications”, Second Edition, Taylor & Francis, 2018.*
4. *Michael T. Goodrich, Roberto Tamassia, David M. Mount, “Data Structures and Algorithms in C++”, Second Edition. John Wiley & Sons, 2011.*

Course Outcomes:

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

CO1: Use appropriate OOPS methodologies to solve real world problem.

CO2: Design and develop programs employing a variety of linear and non-linear data structures such as stacks, queues, binary trees, search trees, heaps, graphs, and B-trees.

CO3: Identify and develop suitable code for sorting, searching and hashing technique.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	M							M	M
CO2	H	H	H	M	L						H	L
CO3	H	M	M	H							M	

Analog Electronic Circuits - I

Semester III
21BELC01

Hours of Instruction /Week: 3T
No. of credits: 3

Objectives:

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

CLO2: To design and analyze BJT and FET small and large signal amplifiers and study their performance with different bias conditions and loads.

Unit I PN Junction Diode 9

Review of Semiconductor physics, PN junction diode, VI characteristics, Applications - rectifiers, clippers and clampers. Zener diode, VI characteristics, avalanche and Zener break down mechanisms, Zener diode as a voltage regulator. Special diodes: varactor diodes, Light Emitting Diodes (LEDs), photo diodes.

Unit II Bipolar Junction Transistor and biasing circuits 9

Construction and operation of Bipolar Junction Transistor, characteristics of CE, CB, CC configurations, hybrid equivalent model, approximate h-parameter model, graphical determination of h parameters, BJT biasing circuits and bias stability.

Unit III Field Effect Transistor and biasing circuits 9

Construction and characteristics of JFET, CS, CD, CG Configurations, FET biasing and bias stability. MOSFET - Construction and characteristics of depletion and enhancement type of MOSFETs.

Unit IV Small Signal Amplifiers 9

BJT amplifiers- CE, CB and CC amplifiers - small signal analysis, low frequency transistor models, estimation of voltage gain, current gain, input resistance, output resistance. Multistage amplifiers, FET amplifiers - CS, CG and CD amplifiers, frequency response of BJT and FET amplifiers.

Unit V 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. Tuned amplifiers - Need for tuned circuits, single Tuned Amplifiers, double tuned, synchronously tuned Amplifiers.

Total Hours: 45

Reference Books:

1. *Sedra Smith, "Microelectronic Circuits"*, 7th Edition, Oxford University Press, 2017.
2. *R. Boylestad and L. Nashelsky, "Electronic Devices & Circuit Theory"*, 11th Edition, PHI Publication, 2012.

Course Outcomes:

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

CO1: Identify various parameters that affect the operating characteristics of diodes, BJT, FET and Opto electronic devices.

CO2: Identify various parameters that effect the operation of Electronic circuits and their performance using BJTs and FETs.

CO3: Design biasing circuits and implement in the laboratory for obtaining the desired operating point and analyze simple amplifier circuits using BJTs and FETs.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M									
CO2	H	H	M		M				M	M		
CO3	H	H	M	L					H	M		

Digital Electronics

Semester III
21BELC02

Hours of Instruction/Week: 3T+1Tu
No. of credits: 4

Objectives:

CLO1: Learn various methods to realise logic circuits.

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

Unit I Boolean Algebra and Simplification 12

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 12

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 15

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 13

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: 60

Reference Books:

1. *M. Morris Mano, "Digital Design"*, 4th Edition, Prentice Hall of India Pvt.Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.
2. *R.P. Jain, "Modern digital Electronics"*, Tata McGraw Hill, 4th edition, 2018.
3. *Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis"*, Prentice Hall PTR, 2nd edition, 2003.
4. *W.H. Gothmann, "Digital Electronics- An introduction to theory and practice"*, PHI, 2nd edition, 2006.
5. *John Michael Williams, "Digital VLSI Design with Verilog"*, Springer International Publishing Switzerland, 2nd edition 2014.

Course Outcomes:

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

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

CO2: Design and implement combinational and sequential circuits using various methods and Verilog HDL code.

CO3: Distinguish between various logic circuits and distinguish between their performance to implement in VLSI circuits.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H						L			
CO2	H	H	H		H				M			
CO3	H	H	M						L			

Signals and Systems

Semester III
21BELC03

Hours of Instruction/Week: 3T+1Tu
No. of credits: 4

Objectives:

- CLO1: To study and analyse characteristics of continuous time, discrete time signals and systems in time domain and various transform domains.
- CLO2: To design and implement simple time domain and frequency domain analysis using MATLAB.

Unit I Introduction to Signals and Systems 15

Continuous-time (CT) & Discrete-Time (DT) signals - Basic CT and DT signals- Representation of signals in terms of impulse function – Classification of CT & DT Signals- Properties of CT & DT systems - Linear Time Invariant systems- Discrete time LTI systems: Convolution Sum – Continuous time LTI systems: Convolution Integral – Unit step response and unit impulse response of LTI systems – LTI systems represented by Linear Constant Coefficient differential and difference equations.

Unit II Fourier analysis of Continuous Time Signals and Systems 12

Representation of CT periodic signals by Continuous Time Fourier Series (CTFS)- Convergence of CTFS – Properties of CTFS - Representation of CT aperiodic signals by Continuous- Time Fourier Transform (CTFT) –Convergence of CTFT - Properties of CTFT- Response of CT LTI systems to complex exponentials - Frequency response of systems characterized by differential equations.

Unit III Fourier analysis of Discrete Time Signals and Systems 12

Representation of DT periodic signals by Discrete Time Fourier Series (DTFS)- Representation of DT aperiodic signals by Discrete Time Fourier Transform (DTFT) – DTFT of DT periodic signals - Convergence of DTFT - Properties of DTFT - Response of DT LTI systems to complex exponentials.

Unit IV Sampling 6

Representation of a continuous time signals by samples- Sampling theorem and Nyquist rate- Reconstruction from samples using interpolation- Effect of under Sampling and over sampling - Aliasing error.

Unit V Laplace Transform and Z Transform 15

Laplace and Inverse Laplace transforms - Properties of Laplace transforms-Analysis and Characterization of LTI system using Laplace transforms- Z Transform and inverse Z transform- Properties of Z transform- Analysis of Characterizations of LTI system using Z transform.

Total Hours: 60

Reference Books:

1. *Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems"*, Pearson, India Reprint, 2015.
2. *Edward W Kamen & Bonnie's Heck, "Fundamentals of Signals and Systems"*, Pearson Education, 2014.
3. *Simon Haykins and Barry Van Veen, "Signals and Systems"*, John Wiley & sons, Second Edition 2012.

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

Course Outcomes:

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

CO1: Analyze the properties of various signals & systems.

CO2: Apply Laplace transform, Continuous Time & Discrete Time Fourier transform and Z transform for signal analysis.

CO3: Analyze continuous time LTI systems using Fourier and Laplace Transforms, discrete time LTI systems using Z transform and DTFT.

CO4: Outline sampling and reconstruction of continuous-time signals.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		M				M	M		
CO2	H	H	H		M				M	M		
CO3	H	H	H	M	M				M	M		
CO4	H	H	H		M				M	M		

Networks and Transmission Lines

Semester III
21BELC04

Hours of Instruction/Week: 3T
No. of credits: 3

Objectives:

CLO1: To study about various network elements and configurations, their characteristics and synthesis methods.

CLO2: Define impedance matching, transmission line characteristics, their importance and measurement.

Unit I Network Configuration 9

Functional classifications of networks - T section- pi section- bridged T- lattice and ladder networks - bisection Theorem.

Filters and Equalizers: 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, Equalizers: Series and shunt equalizers.

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 Caue 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 - Loading and different methods of loading - 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. Power and impedance measurement on lines - Reflection losses - Measurement of VSWR and wavelength.

Total Hours: 45

Reference Books:

1. *John D Ryder, "Networks, lines and fields"*, 2nd Edition, Prentice Hall India, 2015.
2. *Umesh Sinha, "Transmission Lines and Networks"*, SatyaPrakashan Publishers, 6th Edition, 2010.
3. *Sudhakar. A. & Shyam Mohan. S.P, "Network Analysis and Synthesis"*, Tata McGraw Hill Publishing Company Ltd, 2017.
4. *Chakrabarthy A, "Circuit Theory Analysis & Synthesis"*,Dhanpath Rai& Co, NewDelhi, 2018.
5. *G S N Raju, "Electromagnetic Field Theory and Transmission Lines"*, Pearson Education, 2006.

Course Outcomes:

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

CO1: Explain, analyze, and design diverse network configurations, filters, and equalizers.

CO2: Categorize and demonstrate the transmission of signals through transmission lines and interpret its parameters by using measurement techniques.

CO3: Apply impedance matching concepts and solve transmission line loss problems using smith chart and other mathematical models.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M					M		L	
CO2	H	H	M	H	L				M		L	
CO3	H	H	H	H	L				M		M	

Electron Devices and Circuits Practicals

Semester III
21BELC05

Hours of Instruction /Week: 3P
No. of credits: 1.5

Objectives:

- CLO1: To design, implement and test operating characteristics of basic semiconductor devices and verify the theoretical concepts learnt. Compare the performance and infer by performing experiment and simulation.
- CLO2: To conceive, design and analyze the response of various amplifiers.

List of Experiments:

1. VI characteristics of PN Junction diode and Zener diode
2. Implementation of voltage regulator using Zener diode
3. Half wave, full wave and bridge rectifiers with and without filters
4. Clippers and Clampers
5. BJT characteristics and ‘h’ parameter evaluation
6. FET characteristics and estimation of its parameters
7. Transistor biasing methods
8. Design and testing of BJT amplifier
9. Design and testing of FET amplifier
10. Design & testing of Multistage amplifier
11. Design and testing of a Power amplifier
12. Design and testing of single tuned amplifier

Total Hours: 45

Course Outcomes:

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

- CO1:** Design, implement and analyse the performance of various semiconductor devices.
- CO2:** Design, simulate and demonstrate different applications of semiconductor devices.
- CO3:** Design and analyze the response of amplifier circuits.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	M				M	M		
CO2	H	H	M	L	H				M	M		
CO3	H	H	H	M	M				M	M		

Digital Electronics Practicals

Semester III
21BELC06

Hours of Instruction/Week: 3P
No. of credits: 1.5

Objective:

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

List of Experiments:

1. Testing of logic gates.
2. Design and verification of combinational logic circuits (Boolean expression implementation, adder, subtractor, multiplexer, demultiplexer, encoder, decoder, code converters, parity generator, comparator).
3. Testing of flip - flops using gates and ICs.
4. Design and verification of sequential logic circuits (counters, shift registers, ring counter).
5. Design and testing of sequence detector.
6. Implementation of seven segment display system (using counter and decoder).
7. 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, the student 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	H	H	H	L	L				M			L
CO2	H	H	H	L	L				M			L
CO3	H	M	M	L	H				M			L

Probability and Stochastic Processes

(Electronics and Communication Engineering and Integrated M.E. Internet of Things)

Semester IV
21BESM10

Hours of Instruction/ week: 3T+1Tu
No. of credits: 4

Objectives:

- 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

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 Books:

1. *T.Veerarajan (2010), "Probability, Statistics and Random Processes with queueing theory and queueing networks"*, Tata McGraw –Hill, Third Edition.
2. *P.Kandasamy, K.Thilagavathy and K.Gunavathy (2006), "Probability, Random variables and Random processes"*, S.Chand&Co.Ltd, Delhi.
3. *K.S.Trivedi (2016), "Probability and Statistics with Reliability, Queueing and Computer Science Applications"*, Second edition, Prentice Hall of India, New Delhi.

Course Outcomes:

At the end of course, students will be able to

- CO1:** Comprehend the basic concepts of random variables, distribution, and processes for various applications.
- CO2:** Apply the concepts of probability and various random processes in engineering applications with random signals.
- CO3:** Recognise the significance of linear systems with random inputs.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H										M
CO2	H	H										M
CO3	H	H										M

Control Systems

Semester IV
21BELS02

Hours of Instruction/Week: 3T
No. of credits: 3

Objective:

CLO1: To discuss and appreciate the use of control system components and analyse time response, frequency response and stability of open loop and closed loop systems using 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 and block diagram reduction techniques - Signal flow graph

Unit II Time Response 9

Time domain specifications - Types of test inputs, I and II order response - error coefficients - generalized error series - steady state error - P, PI, PD, PID controllers.

Unit III Frequency Response 9

Determination of closed loop response from open loop response, Nichol's Chart - Bode Plot Polar plot.

Unit IV Stability of Control Systems 9

Characteristics equation, location of roots in S plane for stability - Routh Hurwitz criterion - Root locus techniques, construction - gain margin & phase margin - Nyquist stability criterion.

Unit V State Variable Representation 9

State variable representation of SISO & MIMO systems - phase variable and canonical variable methods - state transition matrix - solution of state equations.

Total Hours: 45

Reference Books:

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

Course Outcomes:

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

CO1: Identify the various control system components and analyse their behaviour under various conditions.

CO2: Examine the various time domain and frequency domain response plots using different methods and plots.

CO3: Evaluate the stability criterions using plots, space model and state variables.

CO4: Design stable control systems for various applications.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	L					L			L
CO2	H	M	H	M					L			L
CO3	H	H	H	M					L			L
CO4	H	H	H	L					L			L

Analog Electronic Circuits-II

Semester IV
21BELC07

Hours of Instruction/week: 4T
No. of credits: 4

Objectives:

- CLO1: To design and analyze feedback amplifiers, oscillator circuits and acquire knowledge of designing multivibrator circuits and power supplies.
- CLO2: To discuss the fundamental building blocks of op-amp, its internal circuitry, performance characteristics and learn to design and analyse linear as well as nonlinear applications of op-amp.

Unit I Feedback amplifier and Oscillator Circuits 12

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

Unit II Multivibrator Circuits and Power Supplies 12

Multivibrator – Astable multivibrator, bistable multivibrator, monostable multivibrator, electronically regulated DC power supplies (rectifiers, filters and voltage regulators), Switched mode power supply.

Unit III IC Fabrication and Circuit Configuration for Linear ICs 12

Advantages of ICs over discrete components, manufacturing process of monolithic ICs, BJT Differential amplifiers, current mirrors and current sources, current sources as active loads, Operational Amplifiers- equivalent circuit of op-amp, the ideal operational amplifier, DC and AC Performance Characteristics.

Unit IV Applications of Operational Amplifiers 12

Inverting and Non- Inverting Amplifiers, Adder, subtractor, Differentiator, Integrator, Instrumentation amplifiers, Low pass, high pass, band pass and band stop filters, Comparators, Schmitt trigger, Triangular wave generator, Precision rectifier, 555 timer, 566 VCO, Analog multiplier and PLL.

Unit V Analog to Digital and Digital to Analog Converters 12

Analog switches, high speed sample and hold circuits, Types of D/A converter- Weighted resistor, R-2R ladder, inverted R-2R. A/D converter- Flash, Single slope, Dual slope, Successive approximation.

Total Hours: 60

Reference Books:

1. *Sedra Smith, "Microelectronic Circuits"*, 7th Edition, Oxford University Press, 2017.
2. *R. Boylestad and L. Nashelsky, "Electronic Devices & Circuit Theory"*, 11th Edition, PHI Publication, 2012.
3. *D. Roy Choudary, Shail Jain, "Linear Integrated Circuits"*, 5th Edition, New Age International Pvt. Ltd, 2018.

Course Outcomes:

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

CO1: Design and analyze various feedback amplifiers, oscillator circuits, multivibrators and power supplies.

CO2: Describe and demonstrate the basic construction of op-amps, AC and DC characteristics and

its specification.

CO3: Design, implement and explain the linear as well as non-linear applications, applications for data conversion and of timers of op-amp and analyse its performance.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	M				M	M		
CO2	H	M	L		L				M	L	L	
CO3	H	L	L		L				M	L	M	

Course Outcomes:

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

CO1: Apply various mathematical models to static electric-magnetic fields and interpret their behaviour.

CO2: Analyze the waves in free space and various mediums using Maxwell's equations.

CO3: Examine the behaviour of electromagnetic waves in free space and guided medium so as to suggest for various applications.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H		L	L				L			L
CO2	H	H		M	L				M			L
CO3	H	M		M	M				M			L

Microprocessor and Microcontroller

Semester IV
21BELC09

Hours of Instruction/Week: 3T+1Tu
No. of credits: 4

Objectives:

CLO1: To learn the architecture as well as programming of 8086 microprocessor and 8051 microcontrollers.

CLO2: To interface I/O devices and memory for simple applications.

Unit I 8086 Microprocessor 12
Architecture, signals, minimum and maximum mode, registers, addressing modes, memory segmentation, system bus structure and timing, exception handling.

Unit II Instruction Set and Programming of 8086 12
Data transfer instructions, arithmetic instructions, logical instructions, shift and rotate instructions, branch instructions, loop instructions, NOP and HLT instructions, flag manipulation instructions, byte and string manipulation instructions, assembly language programming -simple programs.

Unit III Memory and I/O Interfacing with 8086 12
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. Case studies: Traffic Light control, LED display, LCD display and Alarm Controller.

Unit IV 8051 Microcontroller 12
Architecture, Special Function Registers (SFRs), I/O pins, ports and circuits, addressing modes, instruction set, assembly language programming - simple programs.

Unit V Interfacing with 8051 Microcontroller 12
Programming 8051 timers, serial port programming, interrupts programming, LCD and keyboard interfacing, ADC and DAC interfacing - waveform generation, sensor interfacing, external memory interface, stepper motor interfacing.

Total Hours: 60

Reference Books:

1. *Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design"*, Second Edition, Prentice Hall of India, 2007.
2. *Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C"*, Second Edition, Pearson education, 2011.
3. *Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware"*, Tata McGraw Hill, 2012.
4. *Ajay V Deshmukh, "Microcontrollers (Theory and Applications)"*, Tata McGraw Hill, 2010.
5. *A.K.Ray, K.M.Bhurchandi, "Advanced Microprocessors and Peripherals Architecture, Programming and Interface"*, Tata McGraw Hill, 2009.

Course Outcomes:

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

CO1: Identify the difference between 8086 Microprocessor and 8051 Microcontroller and explain their operation.

CO2: List and apply various instruction sets and addressing modes of 8086 Microprocessor and 8051

Microcontroller for programming and interfacing.

CO3: Apply the interfacing concepts of memory and I/O devices for simple applications.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M									L	
CO2	H	H	M	L					L		L	L
CO3	H	H	H	L					L		L	L

Computer Networks

Semester IV
21BELC10

Hours of Instruction/Week: 3T
No. of credits: 3

Objectives:

CLO1: Appreciate the importance of OSI/ ISO standard reference model.

CLO2: To make the students learn functionalities of each layer, flow control and congestion control algorithms and various protocols used in network layers.

Unit I	Data Communications	9
Components - Direction of data flow - networks - Components and Categories - Types of connections - Topologies - Protocols and Standards - ISO / OSI model - Transmission media - Coaxial Cable - Fiber Optics - Modems - RS232 Interfacing sequences.		
Unit II	Data Link Layer	10
Error detection and correction - Parity - LRC - CRC - Hamming code - Flow control and Error control: stop and wait - go back N ARQ - selective repeat ARQ - sliding window techniques - HDLC - LAN: Ethernet IEEE 802.3 - 802.4 and IEEE 802.5 - IEEE 802.11 - FDDI - SONET - Bridges.		
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	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 V	Application Layer	9
DNS - SMTP - FDP - HTTP - WWW - Security - Cryptography.		

Total Hours: 45

Reference Books:

1. *Behrouz A. Foruzan, "Data communication and Networking"*, Tata McGraw Hill, 2017.
2. *William Stallings, "Data and computer Communication"*, 6th Edition, Pearson Education, 2017.
3. *James F. Kurose & W. Rouse, "Computer Networking: A Top down Approach Featuring"*, Pearson Education, 2017.
4. *Andrew S. Tannenbaum, "Computer Networks"*, 5th Edition, Prentice Hall of India, 2010.

Course Outcomes:

At the end of the course, student will able to

CO1: Explain the importance of OSI reference model and have a good knowledge about the functionality of all the layers of OSI Model.

CO2: Discuss about the error detection and correction mechanism, routing methods and protocols used in various layers of OSI model.

CO3: Analyse the requirements of a given organizational structure and select the most appropriate networking architecture and technology as per the requirements.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M		L				L	L			L
CO2	H	M		M				L	M			L
CO3	H	H		M				L	M			M

Electronic Circuits Practicals

Semester IV
21BELC11

Hours of Instruction/Week: 3P
No. of credits: 1.5

Objectives:

CLO1: To conceive, design and analyze the response of feedback amplifiers, Oscillators, Wave shaping circuits.

CLO2: To design and analyse linear as well as nonlinear applications of Op-amp.

List of Experiments:

1. Design and testing of feedback amplifier
2. Design and testing of Hartley Oscillator
3. Design and testing of RC Phase Shift Oscillator
4. Design & testing of Astable Multivibrator
5. Design & testing of Monostable Multivibrator
6. Design & testing of Integrator and Differentiator circuits
7. Designing and testing of Inverting and Non-Inverting Amplifier
8. Op –amp as Comparator
9. Op –amp as Schmitt trigger
10. Waveform Generation using Op-Amp
11. Active LPF, HPF, BPF and BEF using Op amp
12. PLL Characteristics and frequency multiplier

Total Hours: 45

Course Outcomes:

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

CO1: Design and analyze the response of feedback amplifier circuits, oscillators and wave shaping circuits.

CO2: Design, implement and analyse the performance of linear as well as non-linear applications of op-amp.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	M				M	M		
CO2	H	L	L		L				M	L	M	

Microprocessor and Microcontroller Practicals

Semester IV
21BELC12

Hours of Instruction/Week: 3P
No. of credits: 1.5

Objective:

CLO1: To learn to write flow chart and use assembly language programs for arithmetic and logical operations in 8086 microprocessor and 8051 microcontrollers. Interface different I/O devices with 8086 microprocessor.

List of Experiments:

8086 Experiments using kits and MASM:

1. Basic arithmetic operations
2. Basic logical operations
3. Basic block operations
4. Code conversion operations
5. Decimal arithmetic operations
6. String manipulations, sorting and searching

I/O Interfacing Experiments:

1. Traffic light control
2. Stepper motor control
3. Keyboard and display
4. Serial interface/ Parallel interface
5. A/D and D/A interface and waveform Generation

8051 Experiments:

1. Basic arithmetic operations and logical operations
2. Unpacked BCD to ASCII conversion
3. Controlling LEDs blinking pattern through UART
4. Echo each character typed on serial terminal.

Total Hours: 45

Course Outcomes:

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

CO1: Write flow chart and compile the basic operations using of 8086 microprocessor and 8051 microcontrollers with assembly language programming and MASM software.

CO2: Demonstrate simple applications of 8086 microprocessor.

CO3: Conceive, design and implement I/O interfaces to 8086 microprocessors for various applications.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	L	H				M		L	L
CO2	H	H	H	L	H				M		L	L
CO3	H	H	H	L	H				M		L	L

E- Waste Management

Semester V
21BEHS11

Hours of Instruction/week: 3T
No. of credits: 3

Objective:

CLO1: To study about effective mechanism to regulate generation, collection, storage, transport, import, export, recycling, treatment and disposal of e-wastes and their legislative rules.

Unit I Introduction 9

E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management.

Unit II E-waste recovery 9

Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India.

Unit III E-waste hazardous on Global trade 9

Essential factors in global waste trade economy, Waste trading as a quint essential part of electronic recycling, Free trade agreements as a means of waste trading. Import of hazardous e-waste in India; India's stand on liberalizing import rules, E-waste economy in the organized and unorganized sector. Estimation and recycling of e-waste in metro cities of India.

Unit IV E-waste control measures 9

Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source.

Unit V E- waste legislation 9

E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016 - Salient Features and its likely implication. Government assistance for TSDFs. The international legislation: The Basel Convention; The Bamako Convention. The Rotterdam Convention. Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union, Restrictions of Hazardous Substances (RoHS) Directive.

Total Hours: 45

Reference Books:

1. *Hester R.E., and Harrison R.M., "Electronic Waste Management Science", 2009.*
2. *Fowler B., " Electronic Waste – 1st Edition (Toxicology and Public Health Issues). Elsevier", 2017.*
3. *Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, New Delhi.*

Course Outcomes:

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

CO1: Learn the environmental impacts of e-waste and apply various concepts learned under e-waste management hierarchy.

CO2: Distinguish the role of various national and internal act and laws applicable for e-waste management and handling.

CO3: Analyze the e – waste management measures proposed under national and global legislations.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	H					M		
CO2	H	M	H	M	H					M		
CO3	H	M	H	M	H					M		

Analog and Digital Communication

Semester V
21BELC13

Hours of Instruction/Week: 3T
No. of credits: 3

Objectives:

- CLO1: To understand the importance of various modulation techniques and effect of various noise sources on modulated signal.
- CLO2: Use various methods to reduce, detect and correct errors in analog and digital communication systems.

- 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 (FDM, Quadrature carrier multiplexing). Angle Modulation-Representation of FM and PM signals, Spectral characteristics of angle modulated signals, Implementation of Angle modulators and demodulators.
- Unit II Effect of Noise on Analog Communication Systems 9**
Review of probability and random process- basic concepts, random processes in frequency domain, Gaussian and white processes. Effect of noise on linear - modulation systems- Baseband system, DSB-SC AM, SSB AM. Effect of noise on angle modulation – Threshold Effect in Angle modulation, Pre-emphasis and De-emphasis Filtering.
- Unit III Pulse Modulation 9**
Sampling process. Pulse Amplitude Modulation, Pulse position modulation, completing the transition from analog to digital, Quantization process, Pulse Code Modulation (PCM), Delta modulation, Differential pulse code modulation, Line codes, Time division multiplexing.
- Unit IV Source and Channel Coding 9**
Source coding – Shannon’s coding theorem, Fano coding, Huffman coding. Shannon’s theorems on channel capacity – Channel coding theorem, trade-off between Bandwidth and signal to noise ratio, E_b/N_0 Trade off. Error control coding - linear block codes- Hamming codes. cyclic codes- encoder of cyclic codes and decoder of cyclic codes.
- Unit V Digital Carrier Modulation Schemes 9**
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 – Bandwidth requirements, Power requirements, Immunity to channel impairments, Equipment complexity. M-ary Signaling Schemes- M-ary coherent PSK, M-ary Differential PSK, M-ary wideband FSK Scheme. Synchronization methods.

Total Hours: 45

Reference Books:

1. *John G.Proakis, Masoud Salehi, "Communications Systems Engineering"*, 2nd Edition, PHI Learning Pvt. Ltd.,2011.
2. *Simon Haykin, Michael Mohar, "Introduction to Analog and Digital Communications"*, John Wiley and Sons,2007
3. *Roberto Togneri, Christopher J.S desilva, "Fundamentals of Information Theory and Coding Design"*, Chapman and Hall/CRC, A CRC Press company, 2006.
4. *J.S Chitode, "Information Coding Techniques"*, Technical publicationsPune,2004.
5. *K. Sam Shanmugam, "Digital and Analog Communication Systems"*, Wiley India Pvt,Ltd, 2017.

Course Outcomes:

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

CO1: Infer various analog, pulse and digital modulation processes and systems.

CO2: Analyze the effect of noise in communication system and methods of error correction due to noise.

CO3: Interpret the need of coding and apply source and channel coding techniques.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M		L							L
CO2	H	M	M		L							L
CO3	H	M	M		L							L

Computer Architecture and Organization

Semester V
21BELC14

Hours of Instruction/Week: 3T
No. of credits: 3

Objectives:

- CLO1: To study internal design of various subsystems of computer such as processor, control and memory and understand the interface between hardware and software.
CLO2: Learn interfacing of I/O devices with computers

Unit I Basic Computer Organisation 9

Basic Structure of computers, functional units, software, performance issues software, machine instructions and programs, types of instructions, instruction set, instruction formats, assembly language, stacks, queues, subroutines.

Unit II Processor and Arithmetic Organisation 9

Processor organization, information representation, number formats. Multiplication & division, ALU design, floating point arithmetic, IEEE 754 floating point formats.

Unit III Control Organisation 9

Control design, instruction sequencing, interpretation, hardwired control - design methods, and CPU control unit. Microprogrammed control - basic concepts, minimizing microinstruction size, multiplier control unit. Microprogrammed computers - CPU control unit.

Unit IV Memory Organisation 9

Memory organization, device characteristics, RAM, ROM, Memory management, concept of cache & associative memories, virtual memory.

Unit V I/O Organisation and Parallel Processing 9

System organization, input - output systems, interrupt, DMA, standard I/O interfaces, concept of parallel processing, pipelining, forms of parallel processing, interconnect network.

Total Hours: 45

Reference Books:

1. *John P.Hayes, 'Computer architecture and Organisation'*, Tata McGraw-Hill, Third Edition, 1998.
2. *V.Carl Hamacher, Zvonko G. Varanasic and Safat G. Zaky, "Computer Organisation"*, V Edition, McGraw-Hill Inc, 1996.
3. *Morris Mano, "Computer System Architecture"*, Prentice-Hall of India, 2000.
4. *P.Pal Chaudhuri, , "Computer organization and design"*, 2nd Edition, Prentice Hall of India, 2007.

Course Outcomes:

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

CO1: Identify various parts of a computer and their operation.

CO2: Discuss arithmetic hardware design, control unit design and memory organisation of computers.

CO3: Explain concepts of I/O processing and pipelining in computers.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L		L				L			L
CO2	H	M	L		L				L			L
CO3	H	M	L		L				L			L

Antennas and Wave Propagation

Semester V
21BELC15

Hours of Instruction /week: 3T
No. of credits: 3

Objectives:

- CLO1: To study fundamentals of antennas and wave propagation at various frequencies and for different applications.
- CLO2: Learn to design different antennas and measure their parameters using various measurement techniques.

Unit I Basic Antenna Concepts 9

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

Unit II Small Antennas and Array Antennas 9

Radiation fields of infinitesimal dipole and half-wave dipole: Radiation resistance, Directivity, Principle of Long wire, Design procedure of dipole. Antenna Arrays: Array of two-point sources, Array of N element linear array: Broad side array, End fire array, Multiplication of Pattern, Concepts of Phased arrays, Binomial array, case study on Adaptive arrays.

Unit III Special Antennas 9

Qualitative discussion and applications of V and Rhombic Antenna, Yagi -Uda antenna - Turnstile antenna - Log periodic antenna - helical antenna (normal mode and axial mode) - Horn antenna - Reflector antennas and their feed systems, Microstrip Antenna, Patch Antenna and Slot 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, Flat earth and curved earth concepts, Sky wave propagation, Virtual height, critical frequency, Maximum usable frequency, Skip distance, Fading and attenuation, Multi hop propagation.

Total Hours: 45

Reference Books:

1. *Balanis E S, "Antenna Theory Analysis and Design"*, John Wiley and Sons Inc, Singapore, 2010.
2. *Prasad K D, "Antennas and Wave Propagation"*, Satya Prakashan, Tech India Publications, New Delhi, Reprint Version 2019.
3. *Harish A R and Scahidananda M, "Antennas and Wave Propagation"*, Oxford University Press, Chennai, 2010.
4. *Edward C Jordan, Keith G Balmain, "Electromagnetic waves and Radiating systems"*, Prentice Hall of India, New Delhi, 2010.

Course Outcomes:

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

CO1: Discuss various antennas and their properties and predict their performance.

CO2: Identify and design various special antennas for specific application and measure test its performance.

CO3: Explain and analyze the propagation characteristics of waves in various mediums.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H							H	M
CO2	H	H	H	M							H	
CO3	H	M	H	M		L	H			H	H	M

Digital Signal Processing

Semester V
21BELC16

Hours of Instruction/Week: 3T+1 Tu
No. of credits: 4

Objectives:

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 of FIR 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 - Applications of DSP.

Total Hours: 60

Reference Books:

1. *John G. Proakis, Dimitrios, G. Manolakis, "Digital Signal processing principles algorithms and applications", 4th Edition, Prentice Hall of India, 2007.*
2. *Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", Tata Mc Graw Hill 2007.*
3. *Oppenheim and Schaffer, "Discrete time Signal processing", , 5th Edition, Prentice Hall of India, 2010.*
4. *B. Venkataramani and M. Bhaskar, "Digital Signal Processor Architecture, programming and applications", Tata McGraw Hill, 2002.*
5. *P.Ramesh Babu , "Digital Signal Processing", 4th edition, Scitech Publications, 2011.*

Course Outcomes:**At the end of the course, the student will be able to****CO1:** Appreciate the properties of DFT to apply DFT to digital signals & systems and analyze Quantization effects of Finite Register Length in realization of Digital Filters.**CO2:** Design IIR and FIR filters and realize the structures of Linear Digital Filters**CO3:** Compare the properties and addressing modes of various processors and use the DSP Processors for various DSP applications.**CO, PO MAPPING**

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		H				M	M		
CO2	H	H	H		H				M	M		
CO3	H	H	H	M	H				M	M		

Analog and Digital Communication Practicals

Semester V
21BELC17

Hours of Instruction/Week: 3P
No. of credits:1.5

Objectives:

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

CLO2: To design and implement multiplexers, demultiplexers, modulators, demodulators using hardware and modern tools.

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 Analog Modulation schemes
6. Delta Modulation and Demodulation
7. Observation (simulation) of signal constellations of BPSK, QPSK and QAM
8. ASK, FSK, PSK and DPSK schemes
9. Study of Radiation Pattern of Antennas (Dipole, Folded Dipole, Horn and Loop etc.)

Total Hours: 45

Course Outcomes:

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

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

CO2: Analyze the behaviour of multiplexers, demultiplexers, modulators, demodulators.

CO3: Use MATLAB tools to simulate and observe constellations diagrams of digital modulation schemes and their behaviour.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L		M				M		M	L
CO2	H	M	L	M	M	M			M		M	L
CO3	H	M	L	L	M				M		M	L

Digital Signal Processing Practicals

Semester V
21BELC18

Hours of Instruction/Week: 3P
No. of credits: 1.5

Objectives:

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, the student will be able to

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

CO2: Design digital filters using various DSP processors and implementation 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	H	H	H		H				M	H	L	
CO2	H	H	H	L	H				M	H	L	
CO3	H	H	H	M	H	M			M	H	L	

Professional Ethics in Engineering

Semester VI
21BEHS12

Hours of Instruction/Week: 3T
No. of credits: 3

Objective:

CLO1: To understand and create awareness of role of Engineers towards Human and moral values, to impart moral and societal values among the learners.

Unit I Human Values 9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

Unit II Engineering Ethics 9

Senses of “Engineering Ethics” – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

Unit III Engineering as Social Experimentation 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

Unit IV Safety, Responsibilities and Rights 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Unit V Global Issues 9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility

Total Hours: 45

Reference Books:

1. *Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”,* Tata McGraw Hill, New Delhi, 2003.
2. *Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”,* Prentice Hall of India, New Delhi, 2004.
3. *Charles B. Fleddermann, “Engineering Ethics”,* Pearson Prentice Hall, New Jersey, 2004.
4. *Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”,* Cengage Learning, 2009
5. *John R Boatright, “Ethics and the Conduct of Business”,* Pearson Education, New Delhi, 2003
6. *World Community Service Centre, “Value Education”,* Vethathiri publications, Erode, 2011

Course Outcomes:**At the end of the course, the students will be able to****CO1:** Identify the basic perception of profession, professional ethics, various moral & social issues, industrial standards, code of ethics and role of professional ethics in engineering field.**CO2:** Analyze the professional rights and responsibilities of an engineer, responsibilities of an engineer for safety and risk benefit analysis.**CO3:** Outline the knowledge about various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives.**CO, PO MAPPING**

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		H	M		H	M			M	M	
CO2	H		M			M	H	M		H		
CO3	M		M			M	H	M				M

VLSI Design

Semester VI
21BELC19

Hours of Instruction/Week: 3T
No. of credits: 3

Objectives:

- CLO1: To learn the basic concepts of VLSI design process, fabrication techniques, properties and behaviour of MOS Transistors theory.
CLO2: To learn to design various logic units for integrated circuits.
CLO3: To learn need for low power, power analysis and estimation techniques.

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-Ionimplantation-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

Reference Books:

1. *Jan M Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits: A Design Perspective"*, 2nd Edition, Prentice Hall of India, 2016.
2. *Douglas A. Pucknell, Kamran Eshraghian, "BASIC VLSI Design"*, Third Edition, Prentice Hall of India, 2011.
3. *Wayne Wolf, "Modern VLSI Design: IP Based Design"*, Prentice Hall, 4th Edition, 2011.
4. *M.J. Sebastian Smith, "Application Specific Integrated Circuits"*, Addison Wesley, 2005.

5. *Kaushik Roy and Sharat C. Prasad “Low Power CMOS VLSI circuit Design”, John Wiley & Sons, New Delhi,2009.*

Course Outcomes:

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

CO1: Explain fabrication, electrical properties and behaviour of MOS Transistors.

CO2: Design different digital logic circuits and arithmetic building blocks using NMOS and CMOS.

CO3: Identify the essential for low power, basic principles, various power analysis and estimation techniques.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	L					M	M		
CO2	H	M	M	L					M	M		
CO3	H	H	H	L					M	M		

Embedded System Design and Architecture

Semester VI
21BELC20

Hours of Instruction/Week: 3T
No. of credits: 3

Objective:

CLO1: To learn the concepts and architecture of embedded systems, ARM Processor, Real time Operating systems and Communication protocols.

Unit I Introduction to Embedded System 9

Definition of Embedded System, Embedded Systems vs General Computing Systems, Introduction to Real Time Embedded system and general-purpose computers, Embedded system components, 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 9

ARM processor family, Application of ARM Processor, The Acorn RISC machine, Architectural inheritance, The ARM programmer's model, ARM development tools, Memory System Architecture, memory types: - RAM, ROM, UV ROM, FLASH Memory, DRAM, Memory maps, Registers and addresses- I/O devices of ARM processor. ARM Instruction Set, 3-stage pipeline ARM organization, 5-stage pipeline ARM organization

Unit III Communication Bus protocols for Embedded System 9

UART and SPI communication protocol, I²C communication protocol, Programming for I²C Protocol, Real time application using RTC, 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, Division, floating point, Inline functions and inline assembly, Portability issues, "C" programs for General purpose I/O, general purpose timer, PWM Modulator, UART, I²C Interface, SPI Interface, ADC, DAC.

Unit V Real Time Operating Systems 9

Introduction to real time operating systems - real time kernel, 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

Reference Books:

1. *Rajkamal, "Embedded Systems: Architecture, Programming and Design"*, Tata McGraw Hill 2008.
2. *Steve Heath "Embedded System design"*, (Elsevier) 2003.
3. *Frank Vahid, Givargis 'Embedded Systems Design: A Unified Hardware/Software Introduction'*, Wiley Publications, 2006
4. *Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing"*, Cengage Learning; Third edition 2011.
5. *NPTEL Prof. Santanu Chaudhary, "Embedded Systems"*, <https://nptel.ac.in/courses/108/102/108102045/>.
6. *L. B. Das, "Embedded Systems"*, Pearson Education, 2013.

Course Outcomes**At the end of the course, the student will be able to****CO1:** Explain the embedded system concepts and architecture of ARM processors.**CO2:** Discuss and apply various Communication bus protocols.**CO3:** Write Embedded C Programming for various Application Development.**CO4:** 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	M	H	M									M
CO2	H	L	H									H
CO3	H	H	H		M							M
CO4	M	L										L

Mobile and Millimeter Wave Communication

Semester VI
21BELC21

Hours of Instruction/Week: 3T
No. of credits: 3

Objective:

CLO1: To understand 5G wireless propagation channel, Millimeter wave Communication System and different architecture of cellular standards.

Unit I Introduction to wireless communication 9

Introduction about wireless communication - technical challenges of wireless communication-applications; Cellular architecture - frequency reuse - channel assignment - handoff - coverage and capacity improvement; Multiple access - FDMA/CDMA/TDMA/SDMA

Unit II Propagation Principles 9

Propagation mechanisms - channel modelling methods - radio channels- indoor channels - outdoor channels - fading channels; Mobile Radio Propagation: Large scale path loss – path loss and propagation models - small scale fading - types of small-scale fading- parameters of mobile multipath channels - statistical models for multipath fading channels.

Unit III Overview of 5G Broadband Wireless Communications 9

Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro). New radio nodes in 4G, characteristics of 4G and 5G and basic architecture. The 5G wireless Propagation Channels: Channel modelling requirements, propagation scenarios and challenges in the 5G modelling, Channel Models for mm Wave MIMO Systems.

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications.

Unit IV Transmission and Design Techniques for 5G 9

Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), Network Slicing, generalized frequency division multiple accesses (GFDMA), non orthogonal multiple accesses (NOMA).

Unit V Millimeter Wave Communications 9

Spectrum regulations, deployment scenarios, beamforming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM).

Total Hours: 45

Reference Books:

1. *Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, 2nd Edition, Prentice Hall of India, 2005.*
2. *Martin Sauter “From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell, 2007.*
3. *Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks”, Cambridge University Press.*
4. *Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathio poulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.*

5. *Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “Millimeter Wave Wireless Communications”*, Prentice Hall Communications.

Course Outcomes:

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

CO1: Explore the evolution of mobile radio communication system, wireless channel propagation model and signal processing techniques.

CO2: Learn 5G Technology advances and their benefits

CO3: Learn Device to device communication and millimeter wave communication

CO4: Illustrate the modulation techniques used in 5G communication

CO, PO Mapping

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M									H
CO2	H	L	M									M
CO3	H	M	M									L
CO4	H	L	M									L

VLSI Design Practicals

Semester VI
21BELC22

Hours of Instruction/Week: 3P
No. of credits: 1.5

Objectives:

CLO1: To design and simulate CMOS inverter, logic gates, combinational and sequential logic circuits.

CLO2: Design, realise and test arithmetic logic circuits and memories.

Experiments to be designed and executed:

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, student will 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	M	M	L	L	H				M	M	L	L
CO2	M	M	L	L	H				M	M	L	L
CO3	M	M	M	L	H				M	M	L	L

Embedded System Practicals

Semester VI
21BELC23

Hours of Instruction/Week: 3P
No. of credits: 1.5

Objectives:

- CLO1: Able to use embedded C for reading the data from port pins.
CLO2: To program and interface with I/O devices and enable the serial communication with external devices.

List of Experiments:

List of Experiments:

Using ARM Processor

1. Flashing of LED
2. Interfacing ADC
3. Interfacing I²C
4. Interfacing SPI ADC
5. Interfacing SPI temperature sensor
6. Interfacing Internal RTC
7. Interfacing Pulse Width Modulation
8. Interfacing Internal DAC 10 bit
9. Interfacing UART
10. ALU Operation

Total Hours: 45

Course Outcomes:

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

CO1: Write an embedded C code for interfacing ARM processor with I/O peripherals such as LED, Keyboard, LCD, Sensors and Motors.

CO2: Demonstrate the serial communication between the devices using ARM processor.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	H		M				M		M	L
CO2		H	H		M				M		M	L

Microwave Engineering and Optical Communication

Semester VII
21BELC25

Hours of Instruction/Week: 3T
No. of credits: 3

Objectives:

- CLO1: To learn about various parameters and build mathematical model to derive these parameters.
- CLO2: Categorize the passive and active Microwave devices.
- CLO3: Discuss the properties, construction and applications of Fiber Optic passive as well as active devices.

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 and Measurements 9

Waveguide Tee junctions and Magic Tee - directional couplers, Power dividers - isolators and circulators, Gunn diode oscillator, varactor diode, tunnel diode and PIN diode. **Microwave Tube:** High frequency limitations of conventional tubes - Theory and application of Two cavity Klystron Amplifier - Reflex klystrons – Cylindrical magnetron oscillators.

Unit III Microwave Measurements 9

VSWR meter, Spectrum Analyzer, Network Analyzer, Power measurement - frequency measurement - impedance measurements.

Case study-Applications of microwaves related to RADAR, 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 - Electromagnetic mode theory of optical propagation - EM wave - modes in planar guide- phase and group velocity - cylindrical fibers- SM fibers.

Unit V Optical Sources and Detector 9

LED structures - surface and edge emitters- internal quantum efficiency- semiconductor laser diode structures- PIN photo detectors- Avalanche photo diode- construction- characteristics and properties-comparison of performance - photo detector noise - Noise sources - signal to noise ratio - Detector response time- Fiber attenuation Measurements - OTDR - Dispersion measurements.

Total Hours: 45

Reference Books:

1. *Liao Y.S., "Microwave devices and circuits"*, 2nd Edition, Prentice Hall of India, 2006.
2. *John M. Senior, "Optical Fiber Communication"*, 3rd Edition, Pearson Education, 2009.
3. *Gerd Keiser, "Optical Fiber Communication"*, 4th Edition. Tata McGraw Hill, 2008.
4. *Annapurna Das, "Microwave Engineering"*, Tata McGraw Hill, 2004
5. *Govind P. Agrawal, "Fiber optic communication"*, 3rd edition, John Wiley & sons, 2007.
6. *R.P. Khare, "Fiber optics and Optoelectronics"*, Oxford University Press, 2007.

Course Outcomes:**At the end of the course, students will able to****CO1:** Explain various microwave as well as fiber optic devices their microwave parameters and discriminate diverse microwave components.**CO2:** Recall and calculate parameters of microwave tubes and optical devices.**CO3:** Identify, predict and illustrate the propagation and design microwave and fiber optic links.**CO, PO MAPPING**

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L				L		M	M
CO2	H	M	L	L	L				L		M	L
CO3	H	H	M	L	L				L		M	L

Digital Image Processing and Computer Vision

Semester VII
21BELC26

Hours of Instruction/week: 3T
No. of credits: 3

Objective:

CLO1: To study the basic principles of Digital Image Processing techniques and to lay the theoretical foundation of image processing and a variety of computer techniques for the design of efficient algorithms for real-world applications.

Unit I Introduction and Digital Image Fundamentals 9

Motivation & Perspective, Applications, Components of Image Processing System, Fundamentals Steps in Image Processing, Image Sampling and Quantization, Some basic relationships like Neighbors, Connectivity, Distance Measures between pixels.

Unit II Image Enhancement in the Spatial and Frequency Domain 9

Image enhancement by point processing, Image enhancement by neighbourhood processing, Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Zooming, Basics of Spatial Filters, Smoothing and Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering.

Unit III Image Restoration and Image Compression 9

Model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations.

Data Redundancies, Image Compression models, Elements of Information Theory, Lossless and Lossy compression, Huffman Coding, Shanon-Fano Coding, Arithmetic Coding, Golomb Coding, LZW Coding, Run Length Coding, Loss less predictive Coding, Bit Plane Coding, Image compression standards.

Unit IV Image Segmentation and Morphological Image Processing 9

Discontinuity based segmentation, similarity-based segmentation, Edge linking and boundary detection, Threshold, Region based Segmentation

Introduction to Morphology, Dilation, Erosion, Some basic Morphological Algorithms

Unit V Object Representation and description and Computer Vision Techniques 9

Introduction to Morphology, Some basic Morphological Algorithms, Representation, Boundary Descriptors, Regional Descriptors, Chain Code, Structural Methods. Review of Computer Vision applications; Fuzzy-Neural algorithms for computer vision applications.

Total Hours: 45

Reference Books:

1. *Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing"*, 2nd edition, Pearson Education.
2. *David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach"*, Prentice Hall
3. *A.K. Jain, "Fundamental of Digital Image Processing"*, PHI.
4. *W.K. Pratt, "Digital Image Processing"*, Taylor & Francis Group, LLC

Course Outcomes:

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

CO1: Apply image transforms and different techniques employed for the enhancement of images.

CO2: Interpret the of image enhancement, compression and restoration for various applications.

CO3: Implement various algorithms for digital image processing and computer vision.

CO4: Use various coding, segmentation techniques and Morphological Algorithms.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		M					M		
CO2	H	H	H		M					M		
CO3	H	H	H		M					M		
CO4	H	H	H		H					M		

Microwave Engineering and Optical Communication Practicals

Semester VI

21BELC27

Objectives:

Hours of Instruction/Week: 3P

No. of credits: 1.5

CLO1: To study, demonstrate and calculate various specifications of microwave components and optical fibers.

CLO2: Design and implement data transmission through fiber links and measure its performance.

List of Experiments:

Microwave Engineering:

1. Study of mode characteristics of Reflex Klystron.
2. Characteristics of Gunn Diode Oscillator, finding appropriate operating points.
3. Study and demonstrate characteristics of directional coupler, E/H Plane, circulator Tee, Magic Tee.
4. Determine the Radiation pattern of Horn Antenna
5. Frequency and wavelength Measurement at Microwave frequencies.
6. Impedance measurement.
7. Testing and measurement of C-band microstrip low pass filter
8. Testing and measurement of C-band microstrip branch-line coupler
9. Testing and measurement of C-band microstrip power divider with and without chip resistor.
10. Testing and measurement of C-band microstrip transmission line.

Optical Communication:

1. Design and demonstration of Analog and digital link using Fibre optic cable.
2. Measurement of bending loss in various optical fibres.
3. Data transmission through Fiber Optic Link and study of modal distortion and overlap distortion.
4. Time Division Multiplexing.
5. Numerical aperture and misalignment loss determination in fibres.

Total Hours: 45

Course Outcomes:

At the end of the course, student will able to

CO1: Identify the electromagnetic field components and verify the specifications of various microwave components.

CO2: Evaluate the characteristics of antennas and compute the parameters of microwave as well as fiber optic components.

CO3: Design and evaluate data transmission in optical fiber link by building multiplexed base band.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	H	L		L				H	M
CO2	H	M	L	M	L		L				H	M
CO3	H	H	M	H	L		L				M	M

Digital Image Processing Practicals

Semester VI
21BELC28

Hours of Instruction/ week: 3P
No. of credits: 1.5

Objectives:

CLO1: To perform the basic operations on images.

CLO2: To design and implement algorithms for the real time image processing Systems / applications.

List of Experiments

1. To perform basic operations on images.
2. To perform histogram equalization.
3. To perform image filtering in spatial domain.
4. To perform image filtering in frequency domain.
5. To perform image restoration.
6. To perform edge detection using various masks.
7. To perform global and adaptive thresholding.
8. To apply morphological operators on an image.
9. To obtain boundary / regional descriptors of an image.
10. To perform 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 analyse the characteristics of images.

CO2: Perform edge detection and noise analysis operations in the images.

CO3: Apply image processing techniques to develop computer aided diagnosis system

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H			H	L				H		
CO2	H	H	M	M	H					H	M	M
CO3	H	H		M	H		L			H		

Non-Credit Mandatory Course

Consumer Affairs

Semester III
21BEMC03

Hours of Instruction/week: 3T

Objective:

CLO1: This paper seeks to familiarize the students with their rights and responsibilities as a consumer, the social framework of consumer rights and legal framework of protecting consumer rights, provides understanding of the procedure of redress of consumer complaints, and the role of different agencies in establishing product and service standards.

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 (IS1), Ag- mark, Hallmarking. Licensing and Surveillance; Role of International Standards: ISO 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

Reference Books:

1. **Khanna, Sri Ram, Savita Hanspal, 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 SapnaChadah (2012). *Consumer Protection in India: Issues and concerns*, IIPA, New Delhi**
5. **RajyalaxrniRao (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, Sonkar Sumit and Parineet Kaur (2016) Regulating Unfair Trade Practices: 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 Chadah Sapna (2010). Consumer, Consumerism and Consumer Protection, Abhijeet Publications.
6. KapoorSheetal (2010) "Advertising-An Essential Part of Consumer's Life-Its Legal and 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, the student 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	M	M						L	L	L	L	
CO2	M	M						L	L	L	L	
CO3	M	M						L	L	L	L	
CO4	M	M						L	L	L	L	
CO5	M	M						L	L	L	L	

Disaster Management

Semester VII
21BEMC04

Hours of Instruction/week: 3T

Objective:

CLO1: To enable the students to create an awareness on Disasters and its types, to study the risk management and development policies taken by government to stop 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. *Singhal J.P. "Disaster Management"*, Laxmi Publications, 2010.
2. *Tushar Bhattacharya, "Disaster Science and Management"*, McGraw Hill India Education Pvt. Ltd., 2012.
3. *Gupta Anil K, Sreeja S. Nair. "Environmental Knowledge for Disaster Risk Management"*, NIDM, New Delhi, 2011.
4. *Kapur Anu, "Vulnerable India: A Geographical Study of Disasters"*, IAS and Sage Publishers, New Delhi, 2010.
5. *Govt. of India: Disaster Management Act*, Government of India, New Delhi, 2005
6. *Government of India, National Disaster Management Policy*, 2009

Course Outcomes:

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

CO1: Understand the basics of disasters, their significance and types

CO2: Explain about the Disaster Risk Reduction

CO3: Familiarize with the relationship between disasters and development

CO4: Describe the disaster risk management in India

CO5: Discuss the case studies related to disaster management

CO, PO MAPPING

COS/ POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		L			L			H	M	L	M
CO2	M		L			L			H	M	L	M
CO3	M		L						H	M	L	M
CO4	L		M			M			H	M	L	M
CO5	L		M						H	M	L	M

Open Elective

Concepts and Servicing of Home Appliances

Semester VII
21BELO01

Hours of Instruction /Week: 3T
No. of credits: 3

Objective:

CLO1: To study the concepts of various audio, video systems and domestic appliances.

Unit I	Audio Systems	9
Concepts and servicing of microphones, Loud speakers, Headphones and Hearing aids.		
Unit II	Video Systems	9
Concepts of Digital Camera - LCD TV, LED TV, Plasma TV, CC TV - DTH Reception- Remote controls of a TV receiver - Health hazard in TV usage - Servicing of Digital Camera.		
Unit III	Digital Systems	9
Concepts and servicing of Calculators, Digital Clocks, Printers, Scanner.		
Unit IV	Domestic Appliances	9
Concepts of Microwave oven, Washing machine, Dishwasher, Air conditioners, Air Cooler, Refrigerators, Induction stove, Electric Cooker,		
Unit V	Miscellaneous Systems	9
Concepts and Servicing of UPS - Burglar Alarm - Phone(landline) and Cell phone - Health hazard in Cell phone usage.		

Note: Specifications to be discussed for all.

Total Hours: 45

Reference Books:

1. *S.P Bali, "Consumer Electronics"*, Pearson education, 2005.
2. *S.N.Biswas, "Industrial Electronics"*, Dhanpatrai & co (p) Ltd, 2000.
3. *"Electronic Projects Volume II"*, EFY Enterprises Pvt Ltd,1996.
4. *Mithel G.K, "Industrial Electronics"*, Khanna Publishers,2000.

Course Outcomes:

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

CO1: Understand the concepts of audio and video system.

CO2: Understanding the working of different Digital systems and their servicing technique.

CO3: Service different Domestic Home Appliances

CO4: Understand health hazards in using the electronic gadgets like Television and Cell phones.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L				L			L			
CO2	M	L				L			L			
CO3	M	L				L	L		L			
CO4	M	L				L	L					

Professional Electives (PE1) - Communications, VLSI, and Networks Domain

Advanced Digital System Design

Semester V
21BELE01

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Digital Electronics

Objectives:

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

CLO2: To design simple applications using VHDL, PLDs, CPLDs and FPGAs.

Unit I Synchronous Sequential Circuit Design 9

Analysis of clocked synchronous sequential circuits and modelling- 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 vending 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 to Altera 7000 series CPLD.

Unit IV FPGAs 9

Introduction to Field Programmable Gate Arrays - Types of FPGA - Xilinx XC3000 series – 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 – Behavioural – structural modelling – 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

Reference Books:

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

Course Outcomes:

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

CO1: Analyse and design synchronous and asynchronous sequential circuits.

CO2: Compare the structure of PLDs and FPGAs to realize sequential circuits.

CO3: Design simple digital systems using VHDL and to apply the design concepts for different applications.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		M							
CO2	H	H	H		M							
CO3	H	H	H		M				H			

Electronic Measurement and Instrumentation

Semester V
21BELE02

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Basic principles of electrical engineering (Circuit Theory), Basic digital and analog electronics

Objective:

CLO1: To explain the importance of measurement systems, working of measuring instruments, to analyze various signal analyzers to create electronic instruments virtually for the automation, 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 – multimeters – Bridge measurements : – Maxwell, Hay, Schering, Wien bridge.

Unit II Basic Electronic Measuring Instruments 9

Electronic multimeters – 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.

Unit III Signal Generators and Analyzers 9

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

Unit IV Digital Instruments 9

Comparison of analog and digital techniques – digital voltmeter – 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

Reference Books:

1. *Albert D.Helfrick and William D.Cooper, “Modern Electronic Instrumentation and Measurement Techniques”,* Pearson / Prentice Hall of India, 2007.
2. *Ernest O. Doebelin, “Measurement Systems- Application and Design”,* TMH, 2007.
3. *Joseph J.Carr, “Elements of Electronics Instrumentation and Measurement”,* Pearson Education, 2003.
4. *Alan. S. Morris, “Principles of Measurements and Instrumentation”,* 2nd Edition, Prentice Hall of India, 2003.
5. *David A. Bell, “Electronic Instrumentation and measurements”,* Prentice Hall of India Pvt Ltd, 2003.

Course Outcomes:

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

CO1: Classify the performance characteristics of each instrument.

CO2: Explain about types of signal analyzers, oscilloscopes and its types for telecommunication applications.

CO3: 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	H	M	M	L					L	L		
CO2	H	M	M	L					L	L		
CO3	H	M	M	L					L	L		

Virtual Instrumentation

Semester V
21BELE03

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Electronic Measurement and Instrumentation

Objective:

CLO1: To understand and apply the concepts of Virtual Instrumentation, fundamentals of G programming, Data acquisition, Hardware and Software and to impart the knowledge on Lab VIEW.

Unit I Fundamentals of Virtual Instrumentation 9

LabVIEW – graphical user interfaces- controls and Indicators – ‘G’ programming –data types – data flow programming –Editing Debugging and Running a Virtual Instrument – Graphical programming palettes and tools – Front panel objects.

Unit II Graphical Programming Environment in VI 9

FOR Loops, WHILE loops, Shift Registers, CASE structure, formula nodes-Sequence structures- Arrays and Clusters- Array operations – Bundle, Unbundle – Bundle/Unbundle by name, graphs and charts – string and file I/O – High level and Low level file I/Os.

Unit III Interfacing DAQ System with PC 9

Basics of DAQ Hardware and Software – Concepts of Data Acquisition and terminology – Installing Hardware, Installing drivers -Configuring the Hardware – addressing the hardware in LabVIEW- Digital and Analog I/O function – Buffered I/O ,Real time Data Acquisition.

Unit IV Simple Programming in VI 9

Simple programs in VI- Advanced concepts in LabVIEW- TCP/IP VI’s ,Synchronization – other elements of Virtual Instrumentation – Bus extensions – PXI -Computer based instruments, Image acquisition and Motion Control.

Unit V Analysis Tools and Simple Applications in VI 9

Fourier transform - Power spectrum - Filtering tools – CRO emulation –Audio signal processing using Signal processing toolkit-Virtual instrumentation application in Biomedical, Process Control and Mechatronics. Different connectivity and data communication.

Total Hours: 45

Reference Books:

1. *Jovitha Jerome, “Virtual Instrumentation using LabVIEW”*, PHI, 2010
2. *Garry M. Johnson, “LabVIEW Graphical Programming”*, Tata McGraw Hill, 1996.
3. *“Labview Basics I and II Manual”*, National Instruments.
4. *Barry Paton, “Sensor, Transducers and LabVIEW”*, PHI, 2000.
5. *Lisa K Wills, “LabVIEW for Everyone”*, PHI,1996

Course Outcomes:

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

CO1: Explain the concepts of virtual instrumentation and G-programming.

CO2: Understand interfacing of DAQ systems with PC and do simple programs in VI.

CO3: Perform analysis using VI.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M		H				H	M	H	
CO2	H	M	H	L	H				H	M	M	H
CO3				H	H				H		H	

Advanced Digital Communication

Semester VI
21BELE04

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Information coding theory, Digital Communication

Objectives:

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; Transorthogonal – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; 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

Reference Books:

1. *Bernard Sklar, "Digital Communications"*, Second Edition, Pearson Education, 2001.
2. *John G. Proakis, "Digital Communication"*, Fifth Edition, Mc Graw Hill Publication, 2008.
3. *M.K.Simon, S.M.Hinedi and W.C.Lindsey, "Digital communication techniques; Signal Design and Detection"*, Prentice Hall of India, New Delhi, 1995.
4. *Richard Van Nee & Ramjee Prasad, "OFDM for Multimedia Communications"* Artech House Publication, 2001.
5. *Stephen G. Wilson, "Digital Modulation and Coding"*, First Indian Reprint, Pearson Education, 2003.
6. *Simon Haykin, "Digital communications"*, John Wiley and sons, 1998.
7. *Theodore S.Rappaport, 'Wireless Communications'*, 2nd edition, Pearson Education, 2002.

Course Outcomes:

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

CO1: Develop the ability to understand the concepts of signal space analysis for coherent and non- coherent receivers.

CO2: Conceptually appreciate different Equalization techniques.

CO3: Possess knowledge on different block codes and convolutional codes.

CO4: Comprehend the generation of OFDM signals and the techniques of multiuser detection.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M						L			L
CO2	H	M	M						L			L
CO3	H	M	M						L			L
CO4	H	M	M						L			L

Advanced Data Communication

Semester VI
21BELE05

Hours of Instruction/Week: 3T
No. of Credits: 3

Prerequisite: Computer Networks

Objectives:

- CLO1: To understand the division of network layers and the components required to build the functionalities of each layer.
- CLO2: To learn the switching, multiplexing techniques and also flow and congestion control algorithms

Unit I Introduction 9

Data Communications, Networks and Network Types, Internet History, Standards and Administration, Digital Data Transmission, DTE-DCE interface.

Data Link Layer: Introduction, Data Link Layer, Nodes and Links, Services, Categories of Links, sub layers, Link Layer Addressing, Address Resolution Protocol.

Unit II Error Detection and Correction Techniques 9

Error Detection and Correction: Types of Errors, Redundancy, detection versus correction, Coding Block Coding: Error Detection, Vertical redundancy checks, longitudinal redundancy checks, Error Correction, Error correction single bit, Hamming code.

Cyclic Codes: Cyclic Redundancy Check, Polynomials, Cyclic Code Encoder Using Polynomials, Cyclic Code Analysis, Advantage of Cyclic Codes, Checksum

Data Link Control: DLC Services, Data Link Layer Protocols, HDLC, Point to Point Protocol.

Unit III MAC Layer Access Techniques and Connecting devices 9

Media Access Control (MAC) Sub Layer: Random Access, ALOHA, Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access with Collision Detection (CSMA/CD), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), Controlled Access- Reservation, Polling- Token Passing, Channelization - Frequency Division Multiple Access (FDMA), Time - Division Multiple Access (TDMA), Code - Division Multiple Access (CDMA).

Wired LANS: Ethernet Protocol, Standard Ethernet, Fast Ethernet, Gigabit Ethernet, 10 Giga bit, Ethernet.

Connecting devices: Passive Hubs, Repeaters, Active Hubs, Bridges, Two Layer Switches, Routers, Three Layer Switches, Gateway, Backbone Networks.

Unit IV Switching and Multiplexing Techniques 9

Switching: Introduction to Switching, Packet Switching, Structure of switch

Multiplexing: Multiplexing, Frequency Division Multiplexing, Time Division Multiplexing.

Spectrum Spreading: Spread Spectrum-Frequency Hopping Spread Spectrum and Direct Sequence Spread Spectrum.

Connecting devices: Passive Hubs, Repeaters, Active Hubs, Bridges, Two Layer Switches, Routers, Three Layer Switches, Gateway, Backbone Networks.

Unit V Network Layer and Routing Techniques

9

Networks Layer: Packetizing, Routing and Forwarding, Packet Switching, Network Layer Performance, IPv4 Address, Address Space, Classful Addressing, Classless Addressing, Dynamic Host Configuration Protocol (DHCP), Network Address Resolution (NATF), Forwarding of IP Packets, Forwarding based on Destination Address, Forwarding based on Label, Routing as Packet Switches.

Unicast Routing: Introduction, Routing Algorithms-Unicast Routing Protocols- Routing Information Protocol (RIP), Open Short Path First.

Total Hours: 45

Reference Books:

1. *B. A. Forouzan, "Data Communications and Networking"*, Fifth Edition, TMH, 2013.
2. *William Stallings, "Data and Computer Communications"*, Eighth Edition, PHI, 2007.
3. *Prakash C. Gupta, "Data Communications and Computer Networks"*, PHI, 2006.
4. *Nader. F. Mir, "Computer and Communication Networks"*, Second Edition, Pearson Prentice Hall Publishers, 2014.
5. *Brijendra Singh, "Data Communications and Computer Networks"*, Second Edition, 2008.

Course Outcomes:

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

CO1: Understand the concepts of Networks and data link layer.

CO2: Acquire the knowledge of error detection, forward and reverse error correction techniques. Also, acquires the knowledge about the significance of Switching circuits and characteristics of Wired LANs

CO3: Compare the performance of different MAC protocols like Aloha, CSMA, CSMA/CA, TDMA, FDMA & CDMA.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M		L				L	L			L
CO2	H	M		M				L	M			L
CO3	H	H		M				L	M			M

Advanced Digital Signal Processing

Semester VI
21BELE06

Hours of Instruction/Week: 3T
No. of Credits: 3

Prerequisite: Signals and Systems, Digital Signal Processing

Objective:

CLO1: To understand and learn the concepts of multirate signal processing, power spectrum estimation, adaptive filters, optimum filters and also 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 polyphase filters – interpolation with polyphase filters – decimation and interpolation with rational sampling factors - multistage implementation of sampling rate convertors.

Unit II Power Spectrum Estimation 9

Introduction to random process - Non parametric 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

Reference Books:

1. *Fliege N J, "Multirate Digital Signal Processing"*, John Wiley and sons, 2010.
2. *Monson H.Hayes, "Statistical Digital Signal Processing and Modeling"*, John Wiley and Sons, Inc., Singapore, 2011.
3. *Widrow B and Stearns .S D, "Adaptive Signal Processing"*, Prentice Hall inc., 2011.
4. *K.P.Soman, K.I.Ramachandran and N.G.Resmi, "Insight into Wavelets from Theory to Practice"*, Third Edition, PHI Learning Private limited, 2010.
5. *Ifeachor E C and Jervis B. W, "Digital Signal Processing: A Practical Approach"*, Prentice Hall,2010.

6. Jaideva C Goswami and Andrew K Chan, “Fundamentals of Wavelets – Theory, Algorithms and Applications”, John Wiley and Sons, Inc., Singapore, 2013.

Course Outcomes:

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

CO1: Appreciate the need of various types of digital filters.

CO2: Explain the nonparametric and parametric methods for power spectrum estimation.

CO3: Analyze and design multirate filters, adaptive filtering techniques using various algorithms.

CO4: 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	H	M	M	L	H				M	M		
CO2	H	M	M	L	H				M	M		
CO3	H	M	M	L	H				M	M		
CO4	H	M	M	L	H				M	M		

Smart Antennas and MIMO

Semester VI
21BELE07

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Antenna and wave propagation, Digital signal processing

Objectives:

- CLO1: Design an antenna with diverse configurations and characteristics
- CLO2: Familiarize in a variety of MIMO systems.

Unit I Introduction to Smart Antennas 9

Need for smart antennas, smart antenna configurations, switched-beam antennas, adaptive antenna approach, space division multiple access (SDMA), architecture of a smart antenna system, receiver, transmitter, benefits and drawbacks, mutual coupling effects.

Unit II DOA Estimation Fundamentals 9

Introduction, the array response vector, received signal model, the subspace, based data model, signal auto-covariance matrices, conventional DOA estimation methods, conventional beam-forming method, capon's minimum variance method, subspace approach to DOA estimation, the MUSIC algorithm, the ESPRIT algorithm, uniqueness of DOA estimates.

Unit III Beamforming Fundamentals 9

The classical beamformer, statistically optimum beamforming weight vectors, the maximum SNR beamformer, the multiple side-lobe canceller and the maximum, SINR beamformer- minimum mean square error (MMSE). direct matrix inversion (DMI), linearly constrained minimum variance (LCMV), adaptive algorithms for beamforming

Unit IV Algorithms 9

The least mean-square (LMS) algorithm, the recursive least-squares (RLS) algorithm, space time processing: introduction, discrete space-time channel and signal models, space-time beamforming, inter-symbol and co-channel suppression.

Unit V Introduction to MIMO systems 9

Joint ISI and CCI suppression, space-time processing for DS-CDMA, capacity and data rates in MIMO systems, single-user data rate limits, multiple-users data rate limits, data rate limits within a cellular system, MIMO in wireless local area networks.

Total Hours: 45

References Books:

1. *Constantine A. Balanis, Panayiotis. I, Ioannides, "Introduction to Smart Antennas"*, Morgan and Claypool publishers, 2007.
2. *Ahmed El Zooghby, "Smart Antenna Engineering"*, Artech House, 2005.
3. *M.J. Bronzel, "Smart Antennas"*, John Wiley, 2004.
4. *T.S. Rappaport and J.C. Liberti, "Smart Antennas for Wireless Communication"*, Prentice Hall (PTR), 1999.

5. *R.Janaswamy, "Radio Wave Propagation and Smart Antennas for Wireless Communication", Kluwer, 2001.*
6. *Lal Chand Godara, "Smart Antennas", CRC press 2004.*

Course Outcomes:

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

CO1 : Understand the performance of smart antennas to analyze MIMO systems.

CO2 : Study the environmental parameters for signal processing of smart antennas.

CO3 : Evaluate requirements for the design and implementation of smart antenna for MIMO systems.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	L	M	L		M	L				H
CO2	H	H	M	M	L		M	L				H
CO3	H	H	H	M	L		M	L				H

Course Outcomes:**At the end of the course, the student will be able to:****CO1:** Understand and apply the neural nets for real world applications such as pattern recognition, speech and decision making.**CO2:** Model a fuzzy system for clustering and classification.**CO3:** Apply genetic programming for soft computing applications.**CO, PO MAPPING**

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M		M				L			L
CO2	H	M	M		L				L			L
CO3	H	H	M		L				L			L

6 D M Pozar, "Microwave Engineering", John Wiley, 2008.

Course Outcomes:

At the end of the course, the student 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.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M					M	M	M	M
CO2	H	M	M	M					M	M	M	M
CO3	H	M	M	M					M	M	L	M

Unit V Power-Train and Body Chassis**9**

Automotive transmissions: Transmission fundamentals, Types-MT, AT, CVT and DCT. Vehicle Braking Fundamentals: Vehicle Dynamics during Braking, Hydraulic Brake System and its Components, Introduction to Anti-lock Braking Systems. Steering Control: Steering System basics, Fundamentals of Electronically Controlled Power Steering: Types, Electronically Controlled Hydraulic System and Electric Power Braking System, Traction Control, Steering and Tires, Electronic Management of Chassis System.

Total Hours: 45**Reference Books:**

1. *William B. Ribbens, "Understanding Automotive Electronics"*, 5th Edition, Butterworth, Heinemann Woburn, 1998.
2. *Tom Denton, "Automobile Electrical and Electronics System"*, Elsevier Publications, Third Edition, 2004.
3. *Judge. A.W., "Modern Electrical Equipment of Automobiles"*, Chapman & Hall, London, 1992.
4. *Vinal. G.W., "Storage Batteries"*, John Wiley & Sons Inc., New York, 1985.

Course Outcomes:**At the end of the course, the student will be able to:****CO1:** Enumerate the construction, characteristics and maintenance of battery, lighting system,

Ignition System and different accessories in automotive system.

CO2: Explain the concepts of automotive sensors and actuators, their applications**CO3:** Define the details of automobile sub-systems.**CO, PO MAPPING**

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	H	M	L			L			
CO2	M	H	H	H	M	L			L			
CO3	M	H	H	H	M	L			L			

Nano and Flexible Electronics

Semester VII
21BELE11

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Engineering Physics, Electronic Devices and Circuits

Objectives:

CLO1: To enable the students to learn the basics of nanoscience 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, Background 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 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

Reference Books:

1. *K.Bamam and D.Vvedensky, "Low Dimensional Semiconductor Structures"*, Cambridge University Book, 2001.
2. *L.Banyai and S.W.Koch, "Semiconductor Quantum Dots"*, World Scientific Publishing, 1993.
3. *J.H. Davies, "An introduction to the physics-of low dimensional semiconductors"*, Cambridge Press, 1998.
4. *Karl Gosser, Peter Glosekotter, Jan Dienstuhl, "Nanoelectronics and Nanosystems"*, Springer, 2004.

5. *Dr.W.R.Fahrner, "Nanotechnology and Nanoelectronics Materials, Devices, Measurement Techniques", Springer, 2005.*
6. *Wong, William S., Salleo, Alberto, "Flexible Electronics: Materials and Application", Springer, U.S./India,2009*
7. *Guozhen Shen, Zhiyong Fan , "Flexible Electronics: From Materials to Devices", World Scientific, U.S,2016 .*
8. *Takao Someya, "Stretchable Electronics", Wiley International, U.S, 2013.*

Course Outcomes:

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

CO1: Interpret technical information about the basics of nano electronics and flexible electronics.

CO2: Design layouts, exemplary circuits and flexible electronic devices with the gained knowledge on flexible electronic materials and technology.

CO3: 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	H	L		M								M
CO2	H	L		M								M
CO3	H	L		M								M

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	L	L	L			L				M
CO2	H	H	M	L	L			L				H
CO3	H	H	M	L	L			L				H

List of Professional Electives (PE2) - IoT Domain
Fundamentals of IoT

Semester V
21BELE21

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Microprocessor and Microcontroller, Embedded systems.

Objectives:

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 Domain specific applications of IoT 9

Home automation, Industry applications, Surveillance applications, Other IoT applications.

Unit V Developing IoTs 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.

Total Hours: 45

Reference Books:

1. *Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach"*, Universities Press, 2015.
1. *Manoel Carlos Ramon, "Intel Galileo and Intel Galileo Gen 2: API Features and Arduino Projects for Linux Programmers"*, Apress, 2014.
2. *Marco Schwartz, "Internet of Things with the Arduino Yun"*, Packt Publishing, 2014.
3. *Cuno Pfister, "Getting Started with the Internet of Things"*, O'Reilly Media, 2011.
4. *Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"* John Wiley & Sons Pvt.Ltd, 2011.

Course Outcomes:

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

CO1: Discuss the fundamentals of Internet of Things, networks and communication aspects.

CO2: Explore the domain applications of Internet of Things.

CO3: Develop Internet of Things applications through different tools.

CO, PO MAPPING

COS/ POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	H					M		
CO2	H	M	H	M	H					M		
CO3	H	M	H	M	H					M		

Course Outcomes:**At the end of the course, the student will be able to****CO1:** Explain and analyze the parallel processing in operating system using efficient scheduling algorithms and multithreading concepts.**CO2:** Identify the resource management techniques for efficient memory and storage management in distributed applications.**CO3:** 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	H	M		L					M			L
CO2	H	M		M					M			L
CO3	H	L		M					M			M

Programming Languages

Semester V
21BELE23

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Basic C Programming

Objective:

CLO1: To learn about the properties, data types, control structuring in a programming language and 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: Subprogram 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

Reference Books:

1. *Terrence W. Pratt Marvin V. Zelkowitz, "Programming languages – Design and Implementation", 3rd Edition, Prentice Hall of India.*
2. *Robert L. Sebesta, "Concepts of Programming Languages", 4th Edition, Pearson Education.*
3. *Seyed H.Roosta, "Fundamentals of Programming Languages, Design & Implementation", Vikas publications.*
4. *Doris Appleby Julius J. Vendekopple, "Programming Languages by Paradigm and Practice", Tata McGraw Hill Edition.*

Course Outcomes:**At the end of the course, the student will be able to:****CO1:** Understand the structure of computer operation and basic programming concepts such as its properties and data types.**CO2:** Analyze the sequence control of the program and implement the concepts of inheritance and polymorphism.**CO3:** Discuss the storage management of a system and parallel processing through real time applications.**CO, PO MAPPING**

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L						L	L	L	L
CO2	H	H	L						M	M	L	M
CO3	H	M	M						M	M	M	M

Printed and Wearable Electronics

Semester VI
21BELE24

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Sensors and Actuators, Fundamentals of IoT, Advanced Digital Signal Processing.

Objective:

CLO1: To understand the need for wearable devices and its application on various sectors such as healthcare, sports, environment monitoring and navigation.

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 - Microneedle based - Types: Noninvasive 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 - Cameras in smart-watches - Use of Wearable Microphones - MEMS microphones - 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

Reference Books:

1. *Toshiyo Tamura and Wenxi Chen, "Seamless Healthcare Monitoring"*, Springer 2018.
2. *Edward Sazonov and Michael R. Neuman, "Wearable Sensors -Fundamentals, Implementation and Applications"*, Elsevier Inc., 2014.
3. *Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment"*, Springer 2010.
4. *Subhas Chandra Mukhopadhyay, "Wearable Electronics Sensors - For Safe and Healthy Living"*, Springer 2015.
5. *Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, "Environmental, Chemical and Medical Sensors"*, Springer Nature Singapore Pvt. Ltd. 2018.

Course Outcomes:

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

- CO1:** Understand the functioning of wearable inertial sensors and analyze the design and development of wearable bio-electrode for developing monitoring devices for healthcare applications.
- CO2:** Discuss and analyze the usage of various biochemical and gas sensors for environment monitoring.
- CO3:** Identify the use of various wearable locomotive tools for navigation and other real time applications.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	M			H	M		M			H
CO2	H	M	M			H	M		M			H
CO3	H	M	M			M	M		M			H

Embedded OS and RTOS

Semester VI
20BELE25

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: C, C++ and Operating System

Objectives:

CLO1: To understand real-time operating system (RTOS) and the types of RTOS.

CLO2: Get an insight into the features of some of the popular Real-Time OS: POSIX, VxWorks, 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, Intertask Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts, I/O Systems – General Architecture, Device Driver Studies, Driver Module explanation, 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

Reference Books:

1. *Venkateswaran Sreekrishnan, “Essential Linux Device Drivers”,* Prentice Hal, March 27, 2008.
2. *J. Cooperstein, “Writing Linux Device Drivers: A Guide with Exercises”,* CreateSpace, 2009.
3. *Qing Li, Elsevier, “Real Time Concepts for Embedded Systems”,* CMP Books, 2003.
4. *Raj Kamal, “Embedded Systems Architecture Programming and Design”,* Tata McGraw Hill.

5. **Prasad, KVK, “Embedded/Real Time Systems Concepts, Design and Programming Black Book”**, New Delhi Dreamtech Press 2007.
6. **“Software Design for Real-Time Systems: Cooling”**, J E Proceedings of 17th IEEE Real-Time Systems Symposium December 4-6, 1996 Washington, DC: IEEE Computer Society.
7. **Jane Liu, “Real-time Systems”**, Pearson Education, Inc. and Dorling Kindersley Publishing Inc, 2000.
8. **Ward,Paul T & Mellor, Stephen J, “Structured Development for Real - Time Systems V1 : Introduction and Tools”**, Pearson, 1986.
9. **Ward,Paul T & Mellor, Stephen J, “Structured Development for Real - Time Systems V2 : Essential Modeling Techniques”**, Yourdon Inc., New York, N.Y., 1985.
10. **Ward,Paul T & Mellor, Stephen J, “Structured Development for Real - Time Systems V3 : Implementation Modeling Techniques”**, Prentice - hall, Inc., 2000.
11. **Simon, David E, “Embedded Software Primer”**, Pearson Education, 2002.

Course Outcomes:

At the end of the course, the student 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 VxWorks RTOS

CO, PO MAPPING

COS/ POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L									
CO2	M	M	L									
CO3	M	M	L									

Wireless Sensor Networks

Semester VI
21BELE26

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Computer Networks.

Objectives:

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 ad hoc network. Sensor Localization, Clock synchronization, Power management, Special WSNs, WSN Applications.

Unit II Architectures 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

Reference Books:

1. *Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.*
2. *Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- an Information Processing Approach", Elsevier, 2007.*
3. *Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks- Technology, Protocols, And Applications", John Wiley, 2007.*
4. *Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.*
5. *Carlos De Moraes Cordeiro, Dharma Prakash Agarwal "Ad Hoc & Sensor Networks: Theory and Applications", World Scientific Publishing Company, 2006.*

Course Outcomes:

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

CO1: Illustrate the concepts, network architectures and applications of wireless sensor networks.

CO2: Design MAC and routing protocols for wireless sensor networks.

CO3: Create WSN infrastructure and Use WSN mote programming platform and tools.

CO, PO MAPPING

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

5. *Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything"*, First Edition, Apress Publications, 2013.
6. *Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet"*, John Wiley and Sons.
7. *Dr. Ovidiu Vermesan, Dr. Peter Friess "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems"*, River Publishers.

Course Outcomes:

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

CO1: Analyze the different networking technologies used in IoT platforms.

CO2: Understand the importance to enable interoperability across IoT platforms and application domain.

CO3: Apply IoT standards in real time design.

CO, PO MAPPING

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	L				H	H	H	
CO2	H	M	M	M	L				H	H	H	H
CO3	H	M	M	M	H				M	M	M	H

Sensors and Actuators

Semester VI
21BELE28

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Basic Electrical Engineering, Electronic Measurement and Instrumentation.

Objective:

CLO1: To understand static and dynamic characteristics of measurement systems and learn different types of actuators, sensors and their applications.

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: Wheatstone 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 flow meters - Sensors based on semiconductor junctions: Thermometers based on semiconductor junctions - Magneto diodes and magneto transistors - Photodiodes and phototransistors - CCD imaging sensors - Ultrasonic sensors - Fiber optic sensors.

Total Hours: 45

Reference Books:

1. *Andrzej M. Pawlak, "Sensors and Actuators in Mechatronics Design and Applications",* Tylor and Francis, 2006.
2. *D. Johnson, "Process Control Instrumentation Technology",* John Wiley and Sons.
3. *D.Patranabis, "Sensors and Transducers",* TMH 2003.

4. *E.O. Doebelin, "Measurement System : Applications and Design"*, McGraw Hill publications
5. *Graham Brooker, "Introduction to Sensors for ranging and imaging"*, Yesdee, 2009.
6. *Herman K.P. Neubrat, "Instrument Transducers – An Introduction to Their Performance and Design"*, Oxford University Press. 22.
7. *Ian Sinclair, "Sensors and Transducers"*, Elsevier, 3rd Edition, 2011.
8. *Jon Wilson , "Sensor Technology Handbook"*, Newne 2004.
9. *Kevin James, "PC Interfacing and Data acquisition"*, Elsevier, 2011.
10. *Ramon PallásAreny, John G. Webster, "Sensors and Signal Conditioning"*, 2nd edition, John Wiley and Sons, 2000.
11. *Clarence W. de Silva, "Sensors and Actuators: Control System Instrumentation"*, CRC Press,2007.

Course Outcomes:

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

CO1: Understand the characteristics of measuring system and discuss functioning of sensors and actuators.

CO2: Compare the functionality of digital sensors and semiconductor device sensors.

CO3: Analyze the various real time applications of sensors and actuators.

CO, PO MAPPING

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L						L			L
CO2	H	L	L						L			M
CO3	H	M	L						M			M

5G Communication in IoT

Semester VI
21BELE29

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Mobile Communication.

Objectives:

CLO1: Familiarize the need of 5th Generation communication systems.

CLO2: Understand the evolution of LTE technology in IoT.

Unit I Introduction and Roadmap to 5G 9

Historical trend and evolution of LTE technology to beyond 4G, Key building blocks of 5G ,5G use cases and System Concepts , The 5G Architecture , IoT: relation to 5G.

Unit II RF Front End for 5G 9

Millimetre wave Communications: Hardware technologies for mm wave systems, Architecture and Mobility, Massive MIMO: Resource allocation and transceiver algorithms for massive MIMO, Fundamentals of baseband and RF implementations in massive MIMO, Beamforming.

Unit III Wireless Technologies 9

Introduction of Wireless Connectivity, Comparison of Wireless Technologies – IEEE802Std: 802.11 (WiFi), 802.15.1 (Bluetooth), 802.15.4 (Zigbee), 802.16 (WiMax), BLE, 4G/5G: Frame Structures and applications

Unit IV Drivers for 5G 9

Introduction to 5G & RF Front-End: LTE Beyond 4G, Building Blocks of 5G, 5GArchitecture, 5G for IoT Applications: Introduction, Historical Trend of Wireless Communication, Evolution of LTE Technology to Beyond 4G, 5G Road map, 10 Pillars of 5G, IoT relation to 5G, From ICT to the whole economy, Rationale of 5G: High data volume, Global initiatives, Standardization activities, 5G system concept. The 5G Architecture – IoT: relation to 5G. Millimeter Wave Communications: Spectrum and regulations, Channel propagations, Hardware technologies for mmW systems, Development scenario,Architecture and mobility , Beamforming, Physical layer techniques.

Unit V 5G Internet, Architecture, Use Cases and System Concept 9

Introduction, Internet of Things and Context-Awareness, Networking Reconfiguration and Virtualization Support, Mobility, Quality of Service Control, Emerging Approach for Resource Over-Provisioning. The 5G architecture: Introduction, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Physical architecture and 5G deployment, 5G use cases and system concept: Use cases and requirements, Use Cases and Challenges, 5G system concept.

Total Hours: 45

Reference Books:

1. *Wei Xiang, KanZheng, Xuemin (Sherman) Shen, “5G Mobile Communications”, Springer, 2017.*
2. *Ajif Osseiran, Jose F. Monserrat and Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016.*
3. *Jonathan rodriguez, “Fundamentals of 5G mobile networks”, John Wiley & Sons, Ltd, 2015.*
4. *Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press,2012.*
5. *David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Cambridge University Press, 2010.*

6. *Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015.*

Course Outcomes:

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

CO1: Understand the evolution of LTE technology and mm wave communication in IoT.

CO2: Design and implement the new wireless technologies and communication interfaces for IoT applications

CO3: Analyze 5G architectures and apply its concepts in IoT systems.

CO, PO MAPPING

COS/ POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		M				M	M	M	H
CO2	H	H	H		M				M	M	M	H
CO3	H	H	H		M				M	M	M	H

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	L	L	L		M	M		
CO2	H	M	M	M	L	L	L		M	M		
CO3	H	M	M	M	L	L	L		M	M		

Reference Books:

1. *Jiawei Han and Michaeline Kamber, "Data Mining: Concepts and Techniques"*, 3rd edition, Morgan Kaufmann, 2012.
2. *Pang-Ning Tan. Michael Steinbach and Vipin Kumar, "Introduction to Data Mining"*, Pearson India, 2009.

Course Outcomes:

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

CO1: Illustrate various models and techniques in data warehousing and data mining for identifying valuable knowledge from raw data.

CO2: Apply techniques like association rule mining, classification and clustering and discover different kinds of patterns.

CO3: Model solutions to real world problems by inculcating the concepts of data mining.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	H	M	L						L	M
CO2	H	H	M	M	M						M	M
CO3	H	H	H	M	H						M	M

Queuing Theory

Semester VII
21BELE32

Hours of Instruction/week: 3T
No. of Credits: 3

Prerequisite: Random Processes and Probability Theory

Objectives:

CLO1: Familiarize the fundamental concepts in probability and queuing models in the field of communication engineering.

CLO2: Learn to apply queuing models in networks, image processing.

Unit I Random Variables 9

Discrete and Continuous random variables, Moments, Moment generating functions, Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions - Functions of a random variable.

Unit II Two-Dimensional Random Variables 9

Joint distributions, Marginal and Conditional distributions, Covariance, Correlation and Linear regression, Transformation of random variables, Central limit theorem (for independent and identically distributed random variables).

Unit III Random Processes 9

Classification – Stationary process – Markov process - Poisson process –Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

Unit IV Queuing Theory 9

Markovian queues – Birth and Death processes – Single and multiple server queuing models – Little’s formula - Queues with finite waiting rooms – Finite source models.

Unit V Non-Markovian Queues & Queueing Networks 9

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/EK/1 as special cases–Series queues – Open and closed Jackson networks.

Total Hours: 45

Reference Books:

1. *Ibe, O.C. “Fundamentals of Applied Probability and Random Processes”, Elsevier, U.P., 1st Indian Reprint, 2007.*
2. *Gross, D. and Harris, C.M., “Fundamentals of Queueing Theory”, Wiley Student, 3rd Edition, New Jersey, 2004.*
3. *Allen, A.O., “Probability, Statistics and Queueing Theory with Computer Applications”, Elsevier, California, 2nd Edition, 2005.*
4. *Taha, H.A., “Operations Research”, Pearson Education, Asia, 8th Edition, 2007.*
5. *Trivedi, K.S., “Probability and Statistics with Reliability, Queueing and Computer Science Applications”, PHI, New Delhi, 2nd Edition, 2009.*

Course Outcomes:

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

CO1: Apply the fundamental knowledge of the probability concepts in communication systems.

CO2: Acquire skills in analyzing queueing models.

CO3: Understand and characterize the phenomenon which evolve with respect to time in a Probabilistic manner.

CO, PO MAPPING

COS/ POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M							M		
CO2	H	M	M							M		
CO3	H	M	M							M		