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)

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

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

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

Programme Specific Outcome:

PSO1: The Programme is designed to impart necessary theoretical and practical knowledge of various components of Internet of Things and to enable post- graduates to pursue research.

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 (NCMC)**							
	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(S&H)	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*	*CIA*	*CE*	*Total*	*Credits*
Fourth Semester									
		Basic Sciences(BS)							
II	21BESM10	Probability and Stochastic Processes (S&H)	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	-	-	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	-	-	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*	*CIA*	*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)**							
	21MEIC01	Digital Image Processing and Computer Vision	4	-	3	50	50	100	4
	21MEIC02	IoT Architecture and Protocols	3	-	3	50	50	100	3
	21MEIC03	Industrial Internship #	-	-	-	100	-	100	1
	21MEIC04	Minor Research Project Phase I	-	0/4	-	100	-	100	2
	21MEIC05	IoT Technology Practicals– I	-	0/3	3	100	-	100	2
	21MEIC06	IoT Technology Practicals -II	-	0/3	3	100	-	100	2
		Professional Electives (PE)							
		Elective - IV	3	-	3	50	50	100	3
		Elective - V	3	-	3	50	50	100	3
		Elective - VI	3	-	3	50	50	100	3
		Open Electives (OE)							
	21MEBO01/ 21MEOO01/ 21MEFO01	Open Elective – I	3	-	3	50	50	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
		Audit Course (AC)							
	21MEMA11/ 21MEMA12/ 21MEMA13	Audit Course-I	3	-	2	100	-	100	Remark

Part	*Course Code*	*Name of Course/ Component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credits*
Eighth Semester									
III		**Core Courses Professional Core (PC)**							
	21MEIC07	Communication Technologies for IoT	3	-	3	50	50	100	3
	21MEIC08	Energy Harvesting Technologies and Power Management for IoT Devices	3	-	3	50	50	100	3
	21MEIC09	Cloud Storage and Computing	3	-	3	50	50	100	3
	21MEIC10	IoT Technology Practicals– III	-	0/3	-	50	50	100	2
	21MEIC11	Seminar-I	1	-	1	100	-	100	1
	21MEIC12	Minor Research Project Phase II	-	0/12	3	100	100	200	6
		Professional Electives (PE)							
		Elective - VII	4	-	3	50	50	100	4
		Elective - VIII	4	-	3	50	50	100	4
		Open Electives (OE)							
	21MEBO01/ 21MEOO01/ 21MEFO01	Open Elective – II	3	-	3	50	50	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
	21MEIL01	Electronics and Communication Engineering- Computer Based Test (CBT)	-	-	2	100	-	100	Remark
		Audit Course (AC)							
	21MEMA21/ 21MEMA22	Audit Course-II	3	-	2	100	-	100	Remark
#6 weeks Industrial Internship during summer vacation									
Ninth Semester									
III		**Core Courses Professional Core (PC)**							
	21MEIC13	Privacy and Security in IoT	4	-	3	50	50	100	4
	21MEIC14	IoT Technology Practicals - IV	-	0/3	-	50	50	100	2
	21MEIC15	Industrial Internship-I [@]	-	-	-	100	-	100	2
	21MEIC16	Major Research Project Phase I	-	0/20	3	100	100	200	10
		Professional Electives (PE)							
		Elective – IX Title of MOOC (SWAYAM-NPTEL) [##]	3	-	-	-	100	100	3
		Elective – X Title of MOOC (SWAYAM-NPTEL) [##]	3	-	-	-	100	100	3

Part	*Course Code*	*Name of Course/ Component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credits*
[##] Two MOOCs through SWAYAM - NPTEL with credit transfer of 6 credits, as an alternative to two Professional Elective Courses Elective IX and Elective X in IX Semester should be completed between 3rd and 9th semester. Title of the MOOC to be specified after enrollment.									
Tenth Semester									
	21MEIC17	Major Research Project Phase II	-	0/36	3	300	300	600	18
	21MEIC18	Seminar-II	-	-	1	100	-	100	2
								Total Credits	**230**
	21MELMC1	**MOOC (Core/Non-Core)**	-	-	-	-	-	-	2
	21MELMC2	**MOOC (Core/Non-Core)**	-	-	-	-	-	-	2

Semester	*Course Code*	*Name of Course/component*	*Hours of Instruction/ week /Course*	*Credit/ Course*
Part – IV Non- Credit Mandatory Courses (NCMC)				
	A. Ability Enhancement Compulsory Courses (AECC)			
1	21BEMC01	Environmental Science	3	Remark
2	21BEMC02	Constitution of India	3	
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 • Body Language, Aptitude Preparation etc. • Work Ethics • Interpersonal Relations • Adapting to the Corporate Culture • Individual Counseling& Guidance • Career Orientation Program related aptitude (Contact followed by online)	3	
8	21MEIL01	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 Integrated M.Tech Degree:

1. **Total credits to be earned in part I, II & III components: 230**
2. **Successful completion of Part IV Non – Credit Mandatory Courses (NCMC).**
3. **Minimum of two 3 credit MOOCs to be completed through SWAYAM – NPTEL as an alternative to two Professional Electives, Elective IX & Elective X in the ninth semester. Additionally, two core/non-core MOOC-NPTEL courses to be completed with 2 credits between 3rd and 9th semester (without credit transfer).**
4. **# 6 to 8 weeks Industrial Internship during 4th and/or 6th semester during summer vacation.**
   @ 6 weeks industrial internship-I during 8th semester summer vacation.

Other courses offered by the Department:

Value Added Course

Part	*Course Code*	*Name of Course/component*
IV	21BELV01	Embedded System for Beginners

List of Audit Courses (Non-Credit Mandatory Course)

S. No.	Course Code	Audit Course-I
1.	21MEMA11	English for Research Paper Writing
2.	21MEMA12	Disaster Management
3.	21MEMA13	Research and Publication Ethics

S. No.	Course Code	Audit Course-II
1.	21MEMA21	Pedagogy Studies
2.	21MEMA22	Value Education

List of Professional Electives (V and VI Semester)

Part	*Semester*	*Course Code*	*Name of Course/component*
III	**V *Semester* Elective I**	21BELE01	Advanced Digital System Design
		21BELE04	Advanced Digital Communication
		21BELE23	Programming Languages
	VI *Semester* Elective II	21BELE07	Smart Antennas and MIMO
		21BELE08	Soft Computing Techniques
		21BELE09	Electronic Product Design
	VI *Semester* Elective III	21BELE21	Fundamentals of IoT
		21BELE22	Operating Systems
		21BELE26	Wireless Sensor Networks

List of Professional Electives (VII to IX Semester)

Part	*Semester*	*Course Code*	*Name of Course/component*
III	**VII Sem*ester* Elective IV**	21MEIE01	Wireless Networks
		21MEIE02	Wireless Sensor Protocols and Programming
		21MEIE03	Sensors and Actuators
	VII Se*mester* Elective V	21MEIE04	IoT Architecture and Standards
		21MEIE05	Data Mining
		21MEIE06	5G Communication in IoT
	VII *Semester* Elective VI	21MEIE07	Printed and Wearable Electronics
		21MEIE08	Embedded OS and RTOS
		21MEIE09	Queueing Theory
	VIII *Semester* Elective VII	21MEIE10	Robotics and Machine Vision
		21MEIE11	Big Data and Cloud Computing
		21MEIE12	Industry 4.0 and Industrial IoT
	VIII *Semester* Elective VIII	21MEIE13	Modbus Protocols and Programming
		21MEIE14	Parallel and Distributed Computing
		21MEIE15	High Speed Networks
	IX *Semester* Elective IX	21MEIE16	**MOOC (12 Weeks Course in SWAYAM-NPTEL)**
	IX *Semester* Elective X	21MEIE17	**MOOC (12 Weeks Course in SWAYAM-NPTEL)**

Professional English-1
(Common to all branches)

Semester I **Hours of instruction/week: 1T+2P**
21BEHS01 **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. ***AyshaViswamohan (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 **Hours of Instruction/ week: 3T+1Tu**

21BESM01 **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- Involutes and Evolutes - 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 2nd Edition, Tata McGraw Hill Publishing Co.Ltd, New Delhi.
2. ***P.Kandaswamy, K.Thilagavathy and K.Gunavathy (2014), Engineering Mathematics, Volume I***, 10th Revised Edition, S. Chand & Co, New Delhi.

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. 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 **Hours of instruction/week: 3T+1Tu**
21BESP01 **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, CO_2, 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 RajendranEngineering 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 PhysicsFirst 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 **Hours of Instruction/week:3P**

21BESP02 **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

SemesterI **Hoursof Instruction/week:3L+1Tu**
21BEES01 No.ofcredits:4
Objective:

CLO1: To provide a comprehensive idea for engineering students about AC and DCcircuit analysis, working principles of basic machines in electrical engineeringandtheirapplications 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)-MeshandNodalanalysisusingMatrixmethod,Thevenin'sandNorton'stheorems-Superpositiontheorem-Reciprocitytheorem - Maximumpowertransfertheorem.

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, powerlosses, 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).

TotalHours: 60

Reference Books:

1. ***R.K.Mehta& A.K.Mal"ProblemsandSolutionsofElectricalCircuitAnalysis"*** CBS Publishers, 2015
2. ***D.P.KothariandI.J.Nagrath,"BasicElectricalEngineering",***TataMcGrawHill,2010.
3. ***E.Hughes,"ElectricalandElectronicsTechnology",*** Pearson,2010.
4. ***JosephEdministerandMahmoodNahri,"ElectricCircuits",***fifthEdition,TataMcGraw Hill New Delhi,2008.
5. ***V.K.Mehta,RohitMehta,"PrinciplesofElectricalMachines",***S.Chand&companyLtd.,Rep rint 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: Comprehendthebasicconceptsofelectric andmagneticcircuits

CO2: DifferentiatepropertiesandAnalyseACaswellasDCcircuitsandvariousmachines,

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	_	_	_

Engineering Graphics

(Common to all branches)

Semester I **Hours of Instruction /week: 1T+4P**
21BEES02 **No. of Credits: 3**

Course Learning Objective:

CLO1: The objective of this course is to develop the students in graphic skill for communication of concepts and ideas in Engineering.

Unit I Projection of Points, Lines and Surfaces 17

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

Unit II Projection of Simple Solids 17

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

Unit III Sectioning of Solids 17

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

Unit IV Isometric, Perspective Projection and freehand sketching 17

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

Unit V Auto CAD 7

Introduction to drafting software, creation of simple geometric bodies using basic primitives (line, arc, circle) and editing the drawings. Practice in drawing orthographic projection

Total Hours: 75

References:

1. Venugopal.K (2008). Engineering Graphics. New Age International (P) Limited.
2. Natarajan K.V (2008).Engineering drawing and graphics. 17th Edition.Private Publisher, Chennai.
3. Bhatt.N.D (2011)"Engineering Drawing" Charotar Publishing House.
4. Kumar M.S (2007). Engineering Graphics. Ninth edition. D.D. Publications, Chennai.
5. Warren J, Luzadder and John.M.Duff (2007). Fundamentals of Engineering Drawing.

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 **Hours of Instruction/week:2P**
21BEES03 **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 **Hours of instruction/week: 2P**
21BEES06 **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 DictionaryOperations 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. ***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: 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 **Hours of Instruction /week: 3T**
21BEMC01

Objective:

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

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 11

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

UNIT II NATURAL RESOURCES 10

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

UNIT III ENVIRONMENTAL POLLUTION 9

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

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

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

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

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

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

TOTAL HOURS: 45

References:

1. ***Raman Sivakumar,"IntroductiontoEnvironmental 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 **Hours of instruction/week:0T+ 2P**
21BEHS02 **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 **Hours of Instruction/ week: 3T+1Tu**

21BESM02 **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 IIICOMPLEX 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 **Hours ofInstruction/week:3T+1Tu**
21BESC01 **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 Materials12
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, oilyness, 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: Tg, tacticity, molecular weight-weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution andsuspension.Conducting polymers, types, mechanism of conductionand Applications.

Unit VPhotochemistry 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 inorder 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 **Hours of Instruction/week:3P**

21BESC02 **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 ionin 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 **Hours of Instruction/Week: 1T + 4P**
21BEES05 **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.

Transforms, Partial Differential Equations and Applications for Electronics Engineering

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

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

21BESM05 **No. of Credits: 4**

Objectives:

CLO1: To impart analytical skills in the students to solve boundary value problems and transform techniques.

CLO2: To serve as a prerequisite for various courses involving signal analysis, modelling and for research.

Unit I Fourier Series **12**

Dirichlet's conditions, General Fourier series, Half range sine and cosine series, Parseval's identity, Harmonic analysis, Applications of Fourier series in signal processing.

Unit II Fourier Transform **12**

The infinite Fourier transform, Sine and cosine transform, Properties, Inversion theorem, Convolution theorem, Parseval's identity, Applications of Fourier transform in filtering, sampling and modulation techniques of communication system.

Unit III Z – Transforms **12**

Definition and properties, Inverse Z transforms, Definition, Properties, Simple problems, Application of Z – transforms in solving difference equations, Applications in digital signal processing.

Unit IV Partial Differential Equations **12**

Formation of partial differential equation by eliminating arbitrary constants and arbitrary functions, Solution of standard types of first order equations, Lagrange's equation, Linear partial differential equation of second and higher order with constant coefficients.

Unit V Boundary Value Problems **12**

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

Total Hours:60

References:

1. ***P.Kandasamy, K.Thilagavathy, and K.Gunavathy (2007), "Engineering Mathematics",*** III semester, First edition, S.Chand&Co,New Delhi.
2. ***T.Veerarajan (2014), "Transforms, Partial Differential Equations and Applications",*** Third Edition, Tata McGraw – Hill Publishing Company Limited, New Delhi.
3. ***E.Kreyzig (2014), "Advanced Mathematics",*** (9^{th} Edition), John Wiley and Sons.(Asia) PvtLtd, Singapore.
4. ***Dennis G. Zill and Michael R.Cullen*****(2012), "*Advanced Engineering Mathematics",*** second edition, CBS Publishers.

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 circuits etc.

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

C++ and Data Structures

Semester III **Hours of Instruction/week: 2T+2P**
21BELS01 **No. of credits: 3**

Objectives:

CLO1: Develop programs using basics and advanced concepts of C++.
CLO2: Apply the concepts of data structures such as linked list, stack, queue, trees and graphs to solve real world problems.

Unit I Objected Orientation using C++ 6

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

Unit II Advanced C++ 6

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

Unit III Linear Data Structures 6

Algorithm – Analysis –Linked Lists - Stacks and queues - Priority Queues-Binary Heap – Applications.

Unit IV Nonlinear Data Structures 6

Trees-Binary trees- binary search tree - AVL trees- Graphs – representation - BFS – DFS - Topological sort- shortest path algorithm -minimum spanning tree

Unit V Sorting, Searching and Hashing 6

Sorting: Insertion Sorting - Selection sort- Insertion sort- Heap sort- Merge sort- Quick sort- Radix sort - Searching: Linear search –binary search – hashing function – collision resolution techniques.

List of Experiments:

1. Implementation of control structures, functions, class and objects in C++
2. Implementation of constructors, destructors and overloading
3. Implementation of inheritance, polymorphism, virtual functions and files
4. Implementation of Linked lists
5. Implementation of Stack and queue
6. Applications of stack and queue ADTs
7. Implementation of Binary trees and operations of binary trees
8. Implementation of Pre-order- In-order- Post-order Tree Traversals.
9. Implementation of binary search tree and AVL tree
10. Implementation of Breadth First Search and Depth First Search
11. Implementation of searching and sorting algorithms
12. Implementation of Hashing techniques

Total Hours: 30+30

Reference Books:

1. ***K.R.Venugopal, Rajkumar Buyya, " Mastering C++",*** 2nd Edition, McGraw Hill Education, 2017.
2. ***M.A.Weiss, "Data Structures and Algorithm Analysis in C++",*** Fourth Edition, Pearson EducationAsia, 2014.
3. ***Dinesh P. Mehta, Sartaj Sahni, "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 **Hours of Instruction /Week: 3T**
21BELC01 **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 them 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",*** 11thEdition, 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 **Hours of Instruction/Week: 3T+1Tu**
21BELC02 **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 **Hours of Instruction/Week: 3T+1Tu**
21BELC03 **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 **Hours of Instruction/Week: 3T**
21BELC04 **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 Cauer forms.

Unit III Transmission Line Theory **9**

General theory of Transmission lines - the transmission line - general solution - The infinite line - Wavelength, velocity of propagation - Waveform distortion - the distortion-less line - 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",*** Satya Prakashan 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, New Delhi, 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 **Hours of Instruction /Week: 3P**
21BELC05 **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 **Hours of Instruction/Week: 3P**
21BELC06 **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 **Hours of Instruction/ week: 3T+1Tu**
21BESM10 **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 **Hours of Instruction/Week: 3T**
21BELS02 **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 **Hours of Instruction/week: 4T**
21BELC07 **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	

Electromagnetics and Waveguides

Semester IV **Hours of Instruction/Week: 3T**
21BELC08 **No. of credits: 3**

Objective:

CLO1: To discuss and analyze the concepts of static electric-magnetic field using Maxwell's equation and evaluate the wave propagation in guided medium for communication applications.

Unit I Vector Analysis **15**

Vector field - Co-ordinate systems: Rectangular, Cylindrical and Spherical Co-ordinate systems - Elementary length, elementary area and elementary volume.

Electrostatistics

Coulomb's Law - Electric field intensity - Calculation of field due to the following charge distributions: (a) Point charge (b) Infinite line charge calculation of field using gauss's law for symmetrical charge distribution - Definition of potential - Potential due to various charge distributions - Potential gradient - Conservative property of field - Current and current density - Continuity of current - Point form of Ohm's Law.

Unit II Steady Magnetic Field **12**

Biot-Savart's law - Ampere's circuital law - Curl - Stoke's theorem - Magnetic field and magnetic flux density - Calculation of magnetic field due to (a) infinitely long straight filament carrying current (b) finite length current element (c) current loop(d) co-axial cable.

Unit III Time Varying Field & Maxwell's Equations **12**

Faraday's law - Displacement current - Maxwell's equations in point form - Maxwell's equation in integral form - Wave equations for free space - Wave equation for a conducting medium.

Unit IV Uniform Plane Waves, Reflection and Refraction **9**

Plane waves in lossy and lossless medium - Reflection by perfect conductor - Reflection by a perfect dielectric - Poynting's theorem: Instantaneous, average and complex Poynting's vector.

Unit V Guided Waves and Waveguides **12**

Waves between parallel planes: Transverse Electric waves, Transverse Magnetic waves, TEM waves, Attenuation in parallel plane guides - Rectangular guides: TM and TE modes, Attenuation in rectangular guides.

Total Hours: 60

References Books:

1. ***U.A.Bakshi, A.V.Bakshi, "Electromagnetic Fields",*** Technical publications, 2017.
2. ***Jordan.F.C. & R.G.Balmain, "Electromagnetic Waves and Radiating Systems",*** 2nd Edition, Prentice Hall of India, 2015.
3. ***N.N.Rao, "Elements of Engineering Electro Magnetic",*** 6th Edition, Prentice Hall of India, 2006.
4. ***Ramos J.R. Whinnery & T.Van Quzer, "Fields and Waves in Communication Electronics",*** 3rd Edition, John Wiley and sons, 2007.
5. ***Plosney.R & R.E.Collin. "Principles and Applications of Electro Magnetic Fields",*** Tata McGraw Hill, 1987.

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 **Hours of Instruction/Week: 3T+1Tu**
21BELC09 **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, LE D 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 **Hours of Instruction/Week: 3T**
21BELC10 **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. Kurouse & 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 **Hours of Instruction/Week: 3P**
21BELC11 **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 **Hours of Instruction/Week: 3P**
21BELC12 **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 programing 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 **Hours of Instruction/week: 3T**
21BEHS11 **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 **Hours of Instruction/Week: 3T**
21BELC13 **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 **Hours of Instruction/Week: 3T**
21BELC14 **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, ThirdEdition, 1998.
2. ***V.Carl Hamacher, Zvonko G. Varanesic 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 ofIndia, 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 **Hours of Instruction /week: 3T**
21BELC15 **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 **Hours of Instruction/Week: 3T+1 Tu**
21BELC16 **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, Dimities, 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 Schafer, "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 **Hours of Instruction/Week: 3P**
21BELC17 **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 **Hours of Instruction/Week: 3P**
21BELC18 **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 **Hours of Instruction/Week: 3T**
21BEHS12 **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 **Hours of Instruction/Week: 3T**
21BELC19 **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-Ion implantation-Deposition-Silicon gate nMOS process-CMOS processes-nWell-pWell-Twin Tub-Silicon on insulator.

Unit II Basic Electrical Properties of MOSFET 9

NMOS and PMOS transistors- Threshold voltage - Threshold voltage equations- MOS device equations - Basic DC equations - Second order effects. **Inverters:** NMOS inverter - Depletion mode and enhancement mode pull ups-Pseudo nMOS Inverter - CMOS inverter – Transfer Characteristics – Noise Margins- Sheet resistance - Area Capacitance - Inverter delay.

Unit III Logic Design 9

Static CMOS logic - Pass transistor- transmission gate logic - NAND gate - NOR gate - Other forms of CMOS logic - Dynamic CMOS logic - Clocked CMOS logic - Precharged domino CMOS logic - Structured design - Simple combinational logic design examples - Parity generator – Multiplexer - Clocked sequential circuits - Two phase clocking - Charge storage - Dynamic register element –D-Flip Flop -Semi static register - JK flip flop - Dynamic shift register.

Unit IV Subsystem Design Process 9

Design of a 4-bit shifter - General arrangement of a 4-bit arithmetic processor - Design of an ALU subsystem - Implementing ALU functions with an adder - Carry look ahead adder - Multipliers - Serial parallel multiplier – Pipelined multiplier array - Booth's Algorithm-Booth's Encoder-Modified Booth's algorithm.

Unit V Low Power VLSI Design 9

Introduction to low power VLSI design-Need for low power- Basic principles of low power design -Sources of Power dissipation.

Power Analysis and Estimation Techniques: Power Analysis-Gate level analysis-Architecture level analysis-Probabilistic Power Analysis-Power Estimation-Circuit level–-High level power estimation.

Total Hours: 45

Reference Books:

1. ***Jan M Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits*: *A DesignPerspective*",** 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 **Hours of Instruction/Week: 3T**
21BELC20 **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, I^2C communication protocol, Programming for I^2C Protocol, Real time application using RTC, Advantages & Disadvantages of I^2C 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, I^2C 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. ***NPTELProf.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 **Hours of Instruction/Week: 3T**
21BELC21 **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 **Hours of Instruction/Week: 3P**
21BELC22 **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 **Hours of Instruction/Week: 3P**
21BELC23 **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 I^2C
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

Digital Image Processing and Computer Vision

Semester VII **Hours of Instruction/week: 3T**
21MEIC01/21BELC26 **No. of credits: 4**

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 12

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 12

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, Smoothening 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 12

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 12

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 12

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		

IoT Architecture and Protocols

Semester VII **Hours of Instruction/week: 3T**
21MEIC02 **No. of credits: 3**

Objectives:

CLO1: To Understand the Architectural Overview of IoT, IoT reference Architecture and Real World Design Constraints

CLO2: To Understand the various IoT Protocols (Datalink, Network, Transport, Session, Service)

Unit I Overview **9**

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

Unit II Reference Architecture **9**

IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.

Unit III IoT Data Link Layer & Network Layer Protocols **9**

PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP

Unit IV Transport & Session Layer Protocols **9**

Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer HTTP, CoAP, XMPP, AMQP, MQTT

Unit V Service Layer Protocols & Security **9**

Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer.

Total Hours: 45

Reference Books:

1. ***Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",*** 1st Edition, Academic Press, 2014.
2. ***Peter Waher, "Learning Internet of Things",*** PACKT publishing, BIRMINGHAM – MUMBAI
3. ***Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things",*** ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
4. ***Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications",*** ISBN: 978-1-118-47347-4, Willy Publications
5. ***Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-onApproach)",*** 1 st Edition, VPT, 2014.

6. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

Course Outcomes:
At the end of the course, the student will be able to
CO1: Explain the concepts of IoT Architecture Reference model and IoT reference architecture.
CO2: Apply IP based protocols and Authentication Protocols for IoT.
CO3: Analyse various IoT Application layer Protocols.

CO, PO MAPPING

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

IoT Technology Practicals-I

Semester VII **Hours of Instruction /Week: 3P**
21MEIC05 **No. of credits: 2**

Objective:

CLO1: To experiment the application areas of the Internet of Things.

List of Experiments:

1. Study of Arduino and Raspberry Pi; Compare their programming capabilities.
2. Developing simple android application.
3. Acquiring location information from GPS/Google Maps.
4. Transferring data serially from PC to microcontroller.
5. How to configure AT Commands.
6. Write a program to Interface LED/ Buzzer/OLED with Arduino / Raspberry Pi that will be on for different duty cycles.
7. Write a program using Arduino / Raspberry Pi to measure output from sensors.
8. Do drive an actuator/ motor write a program for given microcontroller.
9. Write a program to transfer data using Bluetooth from sensor to Microcontroller.
10. Transfer multiple data from sensors to specific memory location of Arduino/ Raspberry Pi.
11. Write a interactive python script on Raspberry Pi3 to implement the serial communication from Raspberry Pi to Arduino and vice versa with the following components a) LED b) Buzzer c) Temperature and humidity sensor d) four channel relay
12. On-chip Temperature measurement through ADC.
13. N MCUode

Total Hours: 45

Course Outcomes:
At the end of the course, the student will be able to
CO1: Develop skills to integrate IOT devices and implement solutions to IoT based problems.
CO2: Create an IoT based application.

CO, PO MAPPING

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

IoT Technology Practicals-II

Semester VII **Hours of Instruction /Week: 3P**
21MEIC06 **No. of credits: 2**

Objective:

CLO1: To explore the interconnection and integration of the physical world and the cyber space and also be able to design & develop IOT Devices.

List of Experiments:

1. Setup a wired and wireless network.
2. Setup application server like apache or NGINIX or file server
3. Build a local firewall using IP tables to restrict a certain traffic to come in or go out of the networking
4. Demonstration of a peer to peer network topology using Coordinator and end device network device types
5. Demonstration of peer to peer communication between Coordinator and end device through Router.
6. Establishing Many to one Communication (Star Network Topology)
7. Establishing Tree Network Topology and Cluster Tree Network
8. Point to point communication of two C-Motes over the radio frequency
9. Multi-point to single point communication of C-Motes over the radio frequency
10. Setting up of an Ad hoc network in infrastructure and ad hoc mode.
11. Using Motes in Master-slave mode and Single Master and many slave mode

Total Hours: 45

Course Outcomes:

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

CO1: Understand the vision of IoT from a global context, and application of IoT.
CO2: Use of Devices, Gateways and Data Management in IoT.
CO3: Building state of the art architecture in IoT.

CO, PO MAPPING

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

Communication Technologies for IoT

Semester VIII **Hours of Instruction/week: 3T**
21MEIC07 **No. of credits: 3**

Objective:

CLO1: To learn the fundamental Communication technologies and standards for IoT.

Unit I RF Basics: Radio Frequency (RF) Fundamentals 9

Introduction to RF & Wireless Communications Systems, RF and Microwave Spectral Analysis, Communication Standards, Understanding RF & Microwave Specifications. Spectrum Analysis of RF Environment, Protocol Analysis of RF Environment, Units of RF measurements, Factors affecting network range and speed, Environment, Line-of-sight, Interference, Defining differences between physical layers- OFDM.

Unit II Cellular Standards 9

Cellular carriers and Frequencies, Channel allocation, Cell coverage, Cell Splitting, Microcells, Pico cells, Handoff, 1st, 2nd, 3rd and 4th Generation Cellular Systems (GSM, CDMA, GPRS, EDGE, UMTS), Mobile IP, WCDMA

Unit III WLAN: Wi-Fi Organizations and Standards 9

IEEE, Wi-Fi Alliance, WLAN Connectivity, WLAN QoS & Power-Save, IEEE 802.11 Standards,802.11- 2007,802.11a/b/g, 802.11e/h/I,802.11n

Unit IV Wi-Fi Hardware & Software 9

Access Points, WLAN Routers, WLAN Bridges, WLAN Repeaters, Direct-connect Aps, distributed connect Aps, PoE Infrastructure, Endpoint, Client hardware and software, Wi-Fi Applications

Unit V WSN & WPN 9

Wireless Personal Area Networks, Bluetooth, Bluetooth Standards, Bluetooth Protocol Architecture, UWB, IEEE 802.15 standards, ZigBee, Sub1GHz, Sensor Networks, coexistence strategies in Sensor Networks, Routing protocols in Wireless Sensor Networks.

Total Hours: 45

Reference Books:

1. ***Theodore S Rappaport, "Wireless Communications – Principles and Practice",*** Pearson Education Pte. Ltd., Delhi
2. ***Stallings, William, "Wireless Communications and Networking"***Pearson Education Pte. Ltd., Delhi
3. ***Miller, Brent A, Bisdikian, Chatschik, "Bluetooth Revealed"***Addison Wesley Longman Pte Ltd., Delhi .
4. ***Wilson, "Sensor Technology hand book,"*** Elsevier publications 2005.
5. ***Andrea Goldsmith, "Wireless Communications,"*** Cambridge University Press, 2005
6. ***Raj Pandya, "Mobile and Personal Communications Services and Systems"*** 1st EditionPHI, New Delhi.
7. ***Tse David and Viswanath Pramod, "Fundamentals of Wireless Communication"*** Cambridge University press, Cambridge
8. ***Schiller, Jochen H, "Mobile Communications"*** Addison Wesley Longman Pte Ltd., Delhi
9. ***Kasera, Sumit, Narang, and Nishit, "3G Networks: Architecture, protocols and procedures based***

on 3GPP specifications for UMTS WCDMA networks"TATA MGH, New Delhi
10. ***Zhao, Feng, Guibas and Leonidas J, "Wireless Sensor Networks: information processing",*** Elsevier, New Delhi.
11. ***Holger Karl and Andreas Wiilig, "Protocols and Architectures for Wireless Sensor Networks"*** John Wiley & Sons Limited 2008.

Course Outcomes:

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

CO1: Explain communication standards, spectrum, Protocol analysis and factors affecting network range in RF and wireless communication system.

CO2: Identify different cellular, wi-fi organization and its standards.

CO3: Illustrate hardware devices in Wi-Fi, protocols and standards in WPN, WSN.

CO, PO MAPPING

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

Energy Harvesting Technologies and Power Management for IoT Devices

Semester VIII **Hours of Instruction /Week: 3T**
21MEIC08 **No. of credits: 3**

Objective:

CLO1: Familiar with basic energy harvesting systems, modelling, nonlinear techniques and its applications.

Unit I Energy Harvesting Systems 9

Introduction – Energy sources – energy harvesting based sensor networks – photovoltaic cell technologies – generation of electric power in semiconductor PV cells types.

Unit II Piezo-Electric Energy Harvesting and Electromechanical Modeling 9

Piezo electric materials – transducers – harvesters – micro generators – strategies for enhancing the performance of energy harvesters. Electromechanical modeling of Lumped parameter model and coupled distributed parameter models and closed – form solutions.

Unit III Electromagnetic Energy Harvesting and Non- Linear techniques 9

Basic principles – micro fabricated coils and magnetic materials – scaling – power maximations – micro and macro scale implementations. Non – linear techniques – vibration control & steady state cases.

Unit IV Energy harvesting Wireless Sensors 9

Power sources for WSN – Power generation – conversion – examples – case studies. Harvesting microelectronic circuits – power conditioning and losses.

Unit V Selected Applications of Energy Harvesting Systems 9

Case studies for Implanted medical devices – Bio –MEMS based applications – harvesting for RF sensors and ID tags – powering wireless SHM sensor nodes.

Total hours: 45

Reference Books:

1. Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva Verissim Paulino, "CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications", springer.
2. Danick Briand, Eric Yeatman, Shad Roundy, " Micro Energy Harvesting".

Course Outcomes:

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

CO1: Understand the various energy sources harvesting based sensor networks
CO2: Learn about the various Piezoelectric materials and Non – linear techniques
CO3: Understand the various Power sources for WSN
CO4: Learn about the applications of Energy harvesting systems

CO, PO MAPPING

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

Cloud Storage and Computing

Semester VIII **Hours of Instruction/week: 3T**
21MEIC09 **No. of credits: 3**

Objectives:

CLO1: To learn cloud computing basics, cloud storage and security.
CLO2: To learn the need for optimization of cloud storage and various cloud service provider.

Unit I Cloud Computing 9

Introduction to the Cloud Computing, History of cloud computing, Cloud service options, Cloud Deployment models, Business concerns in the cloud, Exploring virtualization, Load balancing, Hypervisors, Machine imaging, Cloud market place over view, Comparison of Cloud providers

Unit II Information Storage Security & Design 9

Storage strategy and governance; security and regulations. Designing secure solutions; the considerations and implementations involved. Securing storage in virtualized and cloud environments. Monitoring and management; security auditing and SIEM.

Unit III Storage Network Design 9

Architecture of storage, analysis and planning. Storage network design considerations;NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCoE),design for storage virtualization in cloud computing, host system design considerations.

Unit IV Optimization of Cloud Storage 9

Global storage management locations, scalability, operational efficiency. Global storage distribution; terabytes to petabytes and greater. Policy based information management; metadata attitudes; file systems or object storage.

Unit V Cloud Service Provider 9

Cloud Service Providers: EMC, EMC IT, Captiva Cloud Toolkit, Google CloudPlatform, Cloud Storage, Google Cloud Connect, Google Cloud Print, Google App Engine, Amazon Web Services, Amazon Elastic Compute Cloud, Amazon Simple Storage Service, Amazon Simple Queue ,Service, Microsoft Windows Azure, Microsoft Assessment and Planning Toolkit, SharePoint, IBM Cloud Models, IBM Smart Cloud, SAP Labs, SAP HANA Cloud Platform, Virtualization Services Provided by SAP, Salesforce, Sales Cloud, Service Cloud: Knowledge as a Service, Rack space, VMware, Manjra soft Aneka Platform.

Total Hours: 45

Reference Books:

1. ***Rajkumar Buyya, James Brobergand Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms",*** Wiley, 2011.
2. ***Kai Hwang, GeofferyC.Fox, Jack J.Dongarra, "Distributed and Cloud Computing",***Elsevier, 2012.
3. ***Tim Mather, SubraKumaraswamy, ShahedLatif, O'Reilly, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance",***SPD,2011.
4. ***Bible, Barrie Sosinsky, "Cloud Computing", John Wiley & Sons***. ISBN-13: 978-0470903568.
5. ***Bernard Golden, "Amazon Web Services For Dummies",***ISBN-13:978-18571835
6. ***Rajkumar Buyya, "Cloud Computing: Principles and Paradigms",*** John Wiley &Sons, First

Edition
7. ***Greg Schulz, "Cloud and Virtual Data Storage Networking",*** Auerbach Publications, ISBN: 978-1439851739, 2011.
8. ***Marty Poniatowski, "Foundations of Green IT"*** Prentice Hall; 1st edition, ISBN:978-137043750, 2009.

Course Outcomes:

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

CO1: Explain the core issues of cloud computing such as storage and security.

CO2: Choose the appropriate technologies, algorithms and approaches for the related issues**.**

CO3: Describe cloud security architectures from the perspectives of providers

CO, PO MAPPING

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

IoT Technology Practicals – III

Semester VIII **Hours of Instruction /Week: 3P**
21MEIC10 **No. of credits: 2**

Objectives:

CLO1: To provide an overview of concepts of Cloud Computing.

CLO2: To make the students understand concepts of virtualization and to use cloud as Infrastructure, Platform, Software services.

List of Experiments:

1. setup a local DHCP server
2. setup local DNS server
3. setup a database server and write a script to configure the regular backup
4. Setup an IOT gateway server like RabbitMQ (MQTT)
5. To install MySQL database on Raspberry Pi and perform basic SQL Quarries.
6. Write a program on Arduino/ Raspberry Pi to publish data on MQTT Broker.
7. Write a program to create TCP Server on Arduino / Raspberry Pi and respond to temperature data to TCP client when requested.
8. Create a UDP server on Arduino / Raspberry Pi that will respond to data to UDP client when requested.
9. Store sensed data in remote/cloud database.

Sample list of IoT based projects

I. Home Automation System
ii. Traffic Light Controller
iii. Automatic Irrigation System
iv. Pollution Monitoring System
v. Health Monitoring System

10. Installation and Configuration of virtualization using Kernel-based Virtual Machine (KVM).
11. To Study Cloud security management.

1. **Case study:** Hadoop, Amazon, Aneka.
2. **Case Study:** PAAS (Facebook, Google App Engine)

Total Hours: 45

Course Outcomes:

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

CO1: Create and run virtual machines on open source OS.

CO2: Implement Infrastructure, Identity management and User management and storage as a service.

CO, PO MAPPING

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

Privacy and Security in IoT

Semester IX **Hours of Instruction/week: 4T**
21MEIC13 **No. of credits: 4**

Objectives:

CLO1: To understand the Security requirements in IoT and cryptographic fundamentals for IoT

CLO2: To learn the authentication credentials, access control and various types Trust models for Cloud Security.

Unit I Introduction: Securing the Internet of Things 12

Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things - Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees

Unit II Cryptographic Fundamentals for IoT 12

Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication

Unit III Identity & Access Management Solutions for IoT 12

Identity lifecycle – authentication credentials – IoT IAM infrastructure – Authorization with Publish / Subscribe schemes – access control

Unit IV Privacy Preservation and Trust Models for IoT 12

Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT – self-organizing Things - Preventing unauthorized access.

Unit V Cloud Security for IoT 12

Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – An enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing

Total Hours: 60

Reference Books:

1. Brian Russell, Drew Van Duren, "Practical Internet of Things Security (Kindle Edition)"
2. Securing the Internet of Things, Elsevier
3. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations

Course Outcomes:

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

CO1: To design 'security in' in IOT devices and deployments, and highlight where designs and deployments may have security issues.

CO2: Explain basic concepts and algorithms of cryptography, including encryption/decryption and hash functions.

CO3: Understand the authentication credentials and access control
CO4: Discuss the mechanisms and architectures of various types trust models and cloud security.

CO, PO MAPPING

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

IoT Technology Practicals-IV

Semester IX **Hours of Instruction /Week: 3P**
21MEIC14 **No. of credits: 2**

Objective:

CLO1: To experiment the Internet of Things (IoT) concepts which are related to the study of sensors, actuators, and controllers.

List of Experiments:

1. Study the specifications of various sensors and actuators & its Applications (Students have to prepare Report for the same). Perform Experiment using any 6LowPan platform to measure and data of:
    a. PIR Motion Sensor.
    b. Proximity using Ultrasonic Sensor.
    c. Rain Drop Sensor.
    d. Moisture Sensor.
    e. Temperature Sensor.
    f. Touch Sensor.
    g. Infrared Sensor.
    h. Servo Motor.
    i. RFID Sensor.
    j. Bluetooth Module.
    k. Wi-Fi Module.
2. Getting Started with ESP8266 Wi-Fi SoC
3. Hands-on with on-board peripherals of ESP8266 (power management, LORa
4. Creating a webpage and display the values available through Arduino.
5. OPEN Ended problem: Students are required to submit an IOT based project using the Microcontroller or a Raspberry Pi and connecting various sensors and actuators. The data for the same should be displayed via a webpage or a web dash Board like Nodered/ Thinks Board.

Total Hours: 45

Course Outcomes:

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

CO1: Demonstrate the working of various Microcontrollers like Node MCU, Arduino and Raspberry Pi.
CO2: Creating a webpage through Arduino.
CO3: Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.

CO, PO MAPPING

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

Non-Credit Mandatory Course

Consumer Affairs

Semester III **Hours of Instruction/week: 3T**
21BEMC03

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 (1S1), Ag- mark, Hallmarking. Licensing and Surveillance; Role of International Standards: 1SO an Overview

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

Total hours: 45

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	

Value Added Course
Embedded System for Beginners

Semester III **Hours of Instruction: 40**
21BELV01 **No. of Credits: 2**

Objective:

CLO1: Familiar with concepts of Arduino and Rasperry Pi for real time applications.

Unit I Fundamentals of Electronics **8**

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

Unit II Introduction to Embedded Systems **8**

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

Unit III Introduction to Arduino and Rasperry Pi **8**

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

Unit IV Interfacing Devices with Arduino and Rasperry Pi **8**

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

Unit V IoT Applications **8**

Building IoT Applications using Arduino and Raspberry Pi.

Total Hours: 40

Reference Books:

1. Arduino Made Simple by Ashwin Pajankar.
2. https ://www.arduino.cc/en/Tutorial/HomePage.
3. Arduino-Based Embedded Systems: By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury.
4. https://swayam.gov.in/nd2_aic20_sp04/preview.

Course Outcomes:

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

CO1: Specialized in Embedded System Design using Arduino and Rasperry Pi.

CO2: Think innovatively to implement simple projects using Arduino and Rasperry Pi.

CO, PO MAPPING

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

Audit Course-I

English for Research Paper Writing
(Non-credit Mandatory Course)

Semester VII **Hours of Instruction/week: 3T**
21MEMA11

Objective:

CLO1: To educate the students to write an effective research paper

Unit I **9**

Scientific Papers- Definition, Key characteristics- Clarity, Understanding the signals, Language of a Scientific paper, Research ethics, rights and permissions- originality and authorship, avoiding ambiguity and vagueness.

Unit II **9**

Components of a research paper-Importance and requirements while choosing a title. Importance of Syntax in title, Title as a label, matching title to relevance of study.

Unit III **9**

Preparation of abstract. Types of abstracts, Economy of words, Introduction, Reasons for rules, Citations and abbreviations; Writing of Materials and Methods- Purpose, Materials, online resources, Methods, Measurements and analysis, Need for - Tabular materials, References and correct form and Grammar, Abbreviations and Jargons.

Unit IV **9**

Results and discussion: Results-Contents, striving for clarity, Handling of numbers, Discussion-components, Factual relationship, significance of the paper, Defining scientific truth. Tables and Illustrations- Graphs, Photographs-when, where and how to use. Importance of Conclusion.

Unit V **9**

Citing of references- Rules to follow, reference styles and systems, Titles and inclusive pages, Journal abbreviations. Journal publication- Factors to be considered in choosing the journal, Cover letter to journals for publishing the manuscript. Use and misuse of English in manuscript, Ten commandments of good writing.

Total Hours: 45

Reference Books:

1. ***Day R, "How to Write and Publish a Scientific Paper",*** Cambridge University Press, 2006.
2. ***Goldbort R, "Writing for Science",*** Yale University Press (available on Google Books), 2006.
3. ***Highman N, "Handbook of Writing for the Mathematical Sciences",*** SIAM. Highman's book, 1998.
4. ***Adrian Wallwork, "English for Writing Research Papers",*** Springer New York Dordrecht Heidelberg London, 2011.

Course Outcomes:

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

CO1: Write technical documents/ papers in proper format with clarity and readability.
CO2: Distinguish between quality technical papers as well as articles from average ones.
CO3: Comprehend, investigate, and develop good Quality research papers.

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

Audit Course - I

Disaster Management
(Non-credit Mandatory Course)

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

21MEMA12

Objectives:

CLO1: To provide broad understanding about the basic concepts of disaster management

CLO2: To be familiar with the concepts of risk assessment and disaster mitigation

Unit I Introduction **9**

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Unit II Repercussions of Disasters and Hazards **9**

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Unit III Disaster Prone Areas in India **9**

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

Unit IV Disaster Preparedness and Management **9**

Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness

Unit V Risk Assessment and Disaster Mitigation **9**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co- Operation in Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Total Hours: 45

Reference Books:

1. ***R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies"*** New Royal book Company, 2004.
2. ***Sahni, Pardeep et.al., (Eds.), "Disaster Mitigation Experiences and Reflections",*** Prentice Hall of India, New Delhi, 2009.
3. ***Goel S. L., "Disaster Administration and Management Text and Case Studies"***, Deep & Deep Publication Pvt. Ltd., New Delhi, 2008.

Course Outcomes:

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

CO1: Differentiate between natural and man-made disaster

CO2: Discuss about the repercussions of disasters and hazards and their impacts on society, economy and human lives.

CO3: Describe the different monitoring phenomena, evaluation of risk and management and illustrate the concepts of risk assessment and disaster mitigation

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

Audit Course-I

Research and Publication Ethics
(Non-Credit Mandatory Course)

Semester I **Hours of Instruction/week: 3T**
21MEMA13

Objective:

CLO: To create awareness about the publication ethics and publication misconducts

Unit I Philosophy, Ethics and Scientific Conduct 9

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions
3. Ethics with respect to science and research
4. Intellectual honesty and research integrity
5. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
6. Redundant publications: duplicate and overlapping publications, salami slicing
7. Selective reporting and misrepresentation of data

Unit II Publication Ethics 9

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

Unit III Open Access Publishing & Publication Misconduct 9

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Unit IV Publication Misconduct 9

A. Group Discussions Subject specific ethical issues, FFP, authorship

1. Conflicts of interest
2. Complaints and appeals: examples and fraud from India and abroad

B. Software tools

Use of plagiarism software like Turnitin, Urkund and other open source software tools

Unit V Databases and Research Metrics 9

A. Databases

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics

1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g index, HO index, altmetrics

Total hours: 45

Reference Books:

1. ***Bird, A.*** "***Philosophy of Science"***. Routledge. 2006
2. ***Maclntyre, Alasdair*** "***A Short History of Ethics"***. London. 1967
3. ***P. Chaddah***, "***Ethics in Competitive Research: Do not get scooped; do not get plagiarized"***, ISBN:978- 9387480865 2018
4. ***National Academy of Sciences, National Academy of Engineering and Institute of Medicine. On Being a Scientist: A Guide to Responsible Conduct in Research***: Third Edition. National Academies Press. 2009
5. ***Resnik, D. B. What is ethics in research & why is it important.*** National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfrn6.Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a 2011
6. ***Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance***, ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/ Ethics_Book. pdf 2019.

Course Outcomes:

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

CO1: Infer the importance of publication ethics, scientific misconduct and honesty.
CO2: Understand and apply open access publishing concepts.
CO3: Use available data bases and research metrics for their paper publications.

CO, PO Mapping

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

Audit Course-II

Pedagogy Studies
(Non-credit Mandatory Course)

Semester VIII **Hours of Instruction/week: 3T**
21MEMA21

Objective:

CLO1: To provide the knowledge about pedagogy studies

Unit I Introduction and Methodology 9

Understanding student's cognitive and perceptual abilities, Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teaching Learning outcome, Teacher education, Research questions**,** Overview of methodology and Searching.

Unit II Thematic overview and Learner Intelligences 9

Pedagogical practices, formal and informal classroom, multiple intelligences, Curriculum and syllabus, adopting teaching methods that appeal to different intelligences

Unit III Evidence on the effectiveness of pedagogical practices 9

Methodology of teaching, Materials for teaching, support system for effective pedagogical practices, online and blended classrooms, Thnk-Write-Pair-Share, developing e content, approaches and strategies, engaging learners in the virtual mode, Brain-based learning, Principles of Brain based learning

Unit IV Professional development 9

Follow-up support, Peer, Individual, group learning, Barriers to learning, Special Learning Disabilities, Dyslexia, Dysgraphia, Dyspraxia, Dyscalculia. Use of technological tools to enhance learning, Classroom management, online teaching for rural India

Unit V Measuring attainment in learning and future directions 9

Difference between assessment and Evaluation, Formative and Summative Assessment, Methods of assessing in classroom, Concept Questions and Peer Instruction, Background Knowledge Probe and Peer Review. Rubrics Methods of Evaluation, Inspiring students to be autonomous learners, Online tests, and evaluation (Quizzes. Polling, drag and drop, identification, chat, software tools etc.), motivating students with career guidance and research focus.

Total Hours: 45

Reference Books:

1. http://www.jensenlearning.com/what-is-brain-based-research/
2. ***Anandan, K.N.,"Tuition to Intuition"***, Transcent, Calicut, 2006
3. ***Daniel Kenneth Apple,"***Process Education: Teaching Institute Handbook : Teaching, Learning, Self-grower, Assessment, Facilitation, Curriculum Design", Pacific Crest Software, 1998

4. ***Thomas A. Angelo, K. Patricia Cross,"***Classroom Assessment Techniques: A Handbook for College Teachers", Wiley, 1993
5. ***Harwell, J. M, "Complete Learning Disabilities Handbooks"***, NewYork. The Centre for Applied Research in Education, 1989
6. ***Raj, F, "Breaking Through, A hand book for teachers and parents of children with Specific Learning Disabilities***". VIFA Publications, Secunderabad, 2010.
5. ***Seffetullah Kuldas, Hairul Nizam Ismail, Shahabuddin Hashim***, Unconscious learning processes: mental integration of verbal and pictorial instructional materials

Course Outcomes:

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

CO1: Recognize conceptual framework, pedagogical practices to enhance learning process.

CO2: Analyse learning disabilities and Communicate in a better way with learners of diverse cognitive abilities.

CO3: Appreciate various pedagogy in teaching and attainment of targeted outcomes.

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

Audit Course-II

Value Education
(Non-credit Mandatory Course)

Semester VIII **Hours of Instruction/week: 3T**
21MEMA22

Objective:

CLO1: To provide the knowledge about values in life and self management.

Unit I Value education and Human rights **9**

Value education-Meaning, objectives, importance, Scope and needs. Types-Personal, social, religious, spiritual, universal, cultural and moral values. Values in life and developing a mission statement. Human rights- meaning, and laws on violation of human rights

Unit II Values, goals and standards **9**

Values, goals and standards-meaning and importance in life. Goals- short term and long term goals. Personal goals, family goals. Relationship among values, goals and standards in life. Standards-meaning and its importance and criteria in setting standards and practicing.

Unit III Human values and cultivation of values **9**

Self assessment and self awareness. Importance of cultivation of values-sense of duty, devotion, self reliance, confidence, concentration, truthfulness, Cleanliness, honesty, humanity, Power of faith, National unity, Love for nature, Discipline. Corporate ethics-Ethical values and global values.

Unit IV Personality and behavior development **9**

Social and scientific attitude, developing responsible attitude- Accepting responsibilities in personal and professional life, developing readiness to accept changes in life and society. Integrity and discipline, Effective personality- 7 habits of effective people. Positive thinking- meaning and importance. Understanding positive thinking and self talk, How to avoid negative thinking, Putting into practice and practicing positive thinking in everyday life.

Unit V Importance of character and competence **9**

Character and competence, Achievement motivation, Self-management and good health Importance of religion in life- Holy books vs. Blind faith, Role of women in inculcating moral values in family to nurture good citizens of the society. Self control-meaning, importance and ways to help improve self-control and build good habits.

Total Hours: 45

Reference Books:

1. R.P.Shukla "**Value Education and Education for Human Rights**" - Sarup and sons, New Delhi, 2004.
2. ***Chakraborty S.K., "Values and ethics for organizations- theory and practice***", Oxford University Press, New Delhi, 1998.
3. ***Peale Norman Vincent, "The Power of positive thinking***" Edition 1, 2016

4. ***Home management - Values, Goals and Standards – Brain Kart www.brainkart.com › article › Home-management***
5. ***Frances Bridges, "Contributor careers- self-control,***2018

Course Outcome:

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

CO1: Identify the values and discriminate positive and negative values and practice positive thinking and good moral values.

CO2: Give focus on character formation, competence and personality development.

CO3: Develop good habits, discipline and accept the family and professional responsibilities and lead a meaningful life.

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	

List of Professional Electives (V and VI Semester)

Advanced Digital System Design

Semester V **Hours of Instruction/week: 3T**
21BELE01 **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 - Designof 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. ***ParagK.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			

Advanced Digital Communication

Semester V **Hours of Instruction/week: 3T**
21BELE04 **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; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

Unit IV Convolutional Coded Digital Communication 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

Unit V Multicarrier And Multiuser Communications 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation.Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

Total Hours: 45

Reference Books:

1. ***Bernard Sklar, "Digital Communications",*** Second Edition, Pearson Education, 2001.
2. ***John G. Proakis, "Digital Communication",*** Fifth Edition, McGraw 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

Programming Languages

Semester V **Hours of Instruction/week: 3T**
21BELE23 **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 JuliusJ. Vendekopple, Programming Languages by Paradigm and Practice",*** Tata Mc Graw 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.

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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

Smart Antennas and MIMO

Semester VI **Hours of Instruction/week: 3T**
21BELE07 **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, loannides, "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

Soft Computing Techniques

Semester VI **Hours of Instruction/week: 3T**
21BELE08 **No. of Credits: 3**

Prerequisite: Probability and Numerical Methods, Calculus, Linear Algebra, Set Theory.

Objective:

CLO1: To appreciate the need of soft computing and learn various frame works required to solve fuzzy problems.

Unit I Neural Networks **9**

Basic concepts, Neural Network Architectures, Characteristics, Learning methods. Back propagation networks - Kohnen's self organizing networks - Radial basis function neural networks - Hopfield network, Applications of neural nets such as pattern recognition, speech and decision.

Unit II Fuzzy Systems **9**

Fuzzy sets, Fuzzy Relations and Fuzzy reasoning, Fuzzy functions - Decomposition -Fuzzy automata and languages - Fuzzy control methods - Fuzzy decision making, Industrial Applications.

Unit III Neuro Fuzzy Modelling **9**

Adaptive networks based Fuzzy interface systems - Classification and Regression Trees – Data clustering algorithms - Rule based structure identification - Neuro-Fuzzy controls.

Unit IV Genetic Algorithm **9**

Survive the Fittest - Fitness Computations - Cross over - Mutation - Reproduction – Selection methods.

Unit V Applications of Soft Computing **9**

Optimization of travelling salesman problem using Genetic Algorithm, Genetic algorithm based Internet Search Techniques, Soft computing based hybrid fuzzy controller, Introduction to Environment for Soft Computing Techniques.

Total Hours: 45

References Books:

1. ***Laurene V Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and applications",*** Pearson Prentice Hall, New Delhi, 2008.
2. ***Timothy J Ross, "Fuzzy Logic with Engineering Applications",*** John Wiley & Sons, UK, 2010.
3. ***David E. Goldberg, "Genetic Algorithm in Search Optimization and Machine Learning"***, Pearson Education India, 2013.
4. ***J.S.R.Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing",*** PHI Pearson Education 2004.
5. ***S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing",*** Wiley India Pvt Ltd, 2011.
6. ***S.Rajasekaran and G.A.Vijayalakshmi Pai", Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications",*** Prentice-Hall of India Pvt. Ltd., 2010.
7. ***Simon Haykin, "Neural Networks Comprehensive Foundation",*** Second Edition, Pearson Education, 2005.

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

Electronic Product Design

Semester VI **Hours of Instruction/week: 3T**
21BELE09 **No. of Credits: 3**

Prerequisite: Electronic Circuits, Electronic Devices, Basic Electrical Engineering Electronic Measurement and Instrumentation

Objective:

CLO1: Understand the basics, applications of electronic devices, PCB and RF systems.

Unit I Design of Power Supplies 9

DC power supply - using transistors and SCRs, Design of crowbar and fold back protection circuits - Switched mode power supplies - Forward - fly back - buck and boost converters. Design of transformers and control circuits for SMPS.

Unit II Design of Data Acquisition Systems 9

Low level signals Amplification – Principles of Grounding - Shielding and Guarding techniques, A/D converters: Dual slope, quad slope and high speed - Microprocessors Compatible A/D converters, Logarithmic A/D converters - Sample and Hold circuit.

Unit III RF Design Methodology 9

Behaviour of RF passive components - Chip components and circuit board considerations - Review of transmission lines, Impedance and admittance transformation, Parallel and series connection of networks - ABCD and scattering parameters - RF filter – Basic resonator and filter configurations – Butterworth and Chebyshev filters. Implementation of microstrip filter. Band pass filter and cascading of band pass filter elements.

Unit IV RF Transistor Amplifier Design 9

Amplifier classes of operation and biasing networks – Amplifier power gain, Unilateral design – Simple input and output matching networks – Bilateral design - Stability circle - conditional stability - Simultaneous conjugate matching for unconditionally stable transistors - Broadband amplifiers, High power amplifiers. Multistage amplifiers.

Unit V Design of Printed Circuit Boards 9

Technology of printed circuit boards (PCB), General layout - rules and parameters - PCB design rules for Digital - High Frequency, Analog, Power Electronics and Microwave circuits. Computer Aided design of PCBs

Total Hours: 45

Reference Books:

1 ***Reinhold Luduig and Pavel Bretchko, "RF Circuit Design – Theory and Applications",*** Pearson Education, 2000.
2 ***Sydney Soclof, "Applications of Analog Integrated Circuits",*** PHI, 2005.
3 ***Walter C Bosshart, "Printed circuit Boards – Design and Technology",*** Tata McGraw-Hill, 2003.
4 ***Keith H Billings, "Handbook of Switched Mode Supplies",*** McGraw-Hill, 2010.
5 ***Michael Jaacob, "Applications and Design with Analog Integrated Circuits",*** PHI, 2000.

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

Fundamentals of IoT

Semester VI **Hours of Instruction/week: 3T**
21BELE21 **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. ***ArshdeepBahga, Vijay Madisetti, "Internet of Things – A hands-on approach",*** Universities Press, 2015.
2. ***Manoel Carlos Ramon, "Intel Galileo and Intel Galileo Gen 2: API Features and Arduino Projects for Linux Programmers"***, Apress, 2014.
3. ***Marco Schwartz, "Internet of Things with the Arduino Yun",***Packt Publishing, 2014.
4. ***CunoPfister, "Getting Started with the Internet of Things",***O"Reilly Media, 2011.
5. ***WaltenegusDargie, 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		

Operating Systems

Semester VI **Hours of Instruction/week: 3T**
21BELE22 **No. of Credits: 3**

Prerequisite: Data structures using C++, Computer System Architecture

Objectives:

CLO1: To discuss the basic architectural components of operating system in handling processes and resource management.

Unit I Operating System overview 9

Operating System Structure - OS operations- OS services- System calls- Types of system calls - Process Concept- Process Scheduling- Operations on Process- Threads - Multithreading Models- Threading Issues.

Unit II Process synchronization and scheduling 9

Process synchronization- Critical Section Problem- Synchronization Hardware Semaphores- Classical Problems of synchronization- CPU scheduling- Scheduling Criteria- Scheduling algorithms - Thread Scheduling –Deadlocks- Deadlock characterization- Methods for handling deadlock- Deadlock Prevention- Deadlock Avoidance- Deadlock detection.

Unit III Memory Management 9

Background- Swapping- Contiguous memory allocation- Paging- Segmentation- Virtual memory Management- Background- Demand Paging- Page Replacement - Memory management files.

Unit IV Storage Management 9

Mass storage structure- Disk structure- Disk scheduling- Disk Management – Swap space management- File Concept- Access methods- Directory and disk structure- File system Mounting- File Sharing- Protection- File System Implementation- Directory Implementation- Allocation methods- free space management.

Unit V Case study 9

Linux overview- Administration- Kernel Architecture- Process- memory- file and I/O Management- Mobile OS - Symbian OS- Linux for mobile devices- Android.

Total Hours: 45

Reference Books:

1. ***Abraham Silberschatz. Peter B.Galvin . Greg Gagne, "Operating System Concepts",*** Ninth Edition- Wiley Publisher, 2013.
2. ***SibsankarHaldar. AlexA. Aravind , "Operating Systems",*** Pearson Publication,2010.
3. ***Ann MclverMcHoes , "Understanding Operating Systems",*** Sixth Edition- Course Technology- Cengage Learning Publisher, 2011.
4. www.spokentutorial.org

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

Wireless Sensor Networks

Semester VI **Hours of Instruction/week: 3T**
21BELE26 **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. ***KazemSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, And Applications",*** John Wiley, 2007.
4. ***Anna Hac, "Wireless Sensor Network Designs",*** John Wiley, 2003.

5. ***Carlos De MoraisCordeiro, 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

List of Professional Electives (VII to IX Semester)

Wireless Networks

Semester VII **Hours of Instruction/week: 3T**
21MEIE01 **No. of Credits: 3**

Prerequisite: Mobile Communication, Computer Networks, Wireless Sensor Networks

Objectives:

CLO1: To understand the concept about Wireless networks, protocol stack and standards.
CLO2: Gain in depth knowledge on internetworking of WLAN, WWAN and evolution of 4G Networks, its architecture and applications.

Unit I Wireless LAN 9

Introduction - WLAN technologies:-IEEE802.11: System architecture, protocol architecture, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, WPAN – IEEE 802.15.4, Wireless USB, Zigbee, 6LoWPAN, Wireless HART

Unit II Mobile Network Layer 9

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing: Destination Sequence distance vector, IoT: CoAP

Unit III 3G Overview 9

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3GPP Architecture, User equipment, CDMA2000 overview- Radio and Network components, Network structure, Radio Network, TD-CDMA, TD – SCDMA.

Unit IV Internetworking between WLANs and WWANs 9

Internetworking objectives and requirements, Schemes to connect WLANS and 3G Networks, Session Mobility, Internetworking Architecture for WLAN and GPRS, System Description, Local Multipoint Distribution Service, Multichannel Multipoint Distribution System.

Unit V 4G and Beyond 9

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, IMS Architecture, LTE, Advanced Broadband Wireless Access and Services, MVNO.

Total Hours: 45

Reference Books:

1. ***Jochen Schiller, "Mobile Communications",*** Second Edition, Pearson Education 2012.
2. ***Vijay Garg, "Wireless Communications and networking",*** First Edition, Elsevier 2007.
3. ***Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", ***Second Edition, Academic Press, 2008.
4. ***Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking",*** First Edition, Elsevier 2011.
5. ***Simon Haykin, Michael Moher, David Koilpillai, "Modern Wireless Communications",*** First Edition, Pearson Education 2013.

Course Outcomes:

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

CO1: Apply the 3G/4G networks and its architecture.

CO2: Design and implement wireless network environment for any application using latest wireless protocols and standards.

CO3: Implement different type of applications for smartphones and mobile devices with latest network strategies.

CO, PO MAPPING

COs/ POs	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L									
CO2	H	M	M					L	M	M		M
CO3	H	H	M	M	H		M	M	H	H		M

Wireless Sensor Protocols and Programming

Semester VII **Hours of Instruction/Week: 3T**
21MEIE02 **No. of Credits: 3**

Prerequisite: Computer Networks

Objectives:

CLO1: To understand the wireless sensor network protocols and layers.

CLO2: To learn about the sensor networks platforms and tools.

Unit I MAC Protocols for Wireless Sensor Networks 9

Fundamentals of Medium access protocol- Medium access layer protocols -Issues in Designing a MAC protocol for Wireless Sensor Networks, Design goals of a MAC Protocol for Wireless Sensor Networks, Classifications of MAC Protocols, Contention – Based Protocols, Contention – Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

Unit II Routing Protocols 9

Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols, Proactive Routing. Multichip and cluster based routing protocols.

Unit III Transport Layer and Security Protocols 9 Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.

Unit IV Epidemic Models, Algorithms, and Protocols in Wireless Sensor 9

Overview of Epidemic Theory-Data Dissemination in Sensor Networks: Model and Protocols-Code Update Protocols in Sensor Networks.

QoS-Based Communication Protocols in Wireless Sensor Networks: QoS in Wireless Sensor Networks-QoS-Based MAC Protocols for WSNs-QoS-Based Routing Protocols For WSNs-QoS-Based Computation with Communication Support-QoS-Based Capacity Estimation in WSNs

Unit V Sensor Networks Platforms and tools 9

Research issues and trends, Platforms-Standards and specifications-EE802.15.4/ Zigbee, Hardware: Telosb, Micaz motes, Software: Overview of Embedded operating systems-Tiny OS, Introduction to Simulation tools- TOSSIM, OPNET, NS2,NS3.Wireless Communication characteristics - Link quality, fading effects, Shadowing, Localization, Connectivity and Topology - Sensor deployment mechanisms, Coverage issues, Node discovery protocols.

Total Hours: 45

Reference Books:

1. ***WaltenegusDargie, Christian Poellabauer , "Fundamentals of Wireless Sensor Networks, Theory and Practice",*** Wiley Series on wireless Communication and Mobile Computing, 2007.
2. ***KazemSohraby, Daniel manoli , "Wireless Sensor networks- Technology, Protocols and Applications",*** Wiley InterScience Publications 2010.
3. ***BhaskarKrishnamachari , " Networking Wireless Sensors",*** Cambridge University Press, 2005.
4. ***Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks",*** John Wiley, 2005.
5. ***Ian F. Akyildiznad and Mehmet Can Vuran, "Wireless Sensor Networks (1st Ed.)"*** Wiley-IEEE press (2010).
6. ***KazemSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, and Applications",*** John Wiley, 2007.
7. ***JagannathanSarangapani, "Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control",*** CRC Press.
8. ***C. Siva Ram Murthy and B.S.Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols",***PHI, 2004.
9. ***Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach",***Elsevier, 2007.
10. ***AzzedineBoukerche, "Algorithms and Protocols for Wireless Sensor Networks",*** John Wiley & sons. 2009.

Course Outcomes:

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

CO1: Explain and AnalyzeMAC protocols, mobility and its impact on routing protocols, application performance of WSNs.

CO2: Discuss the quality of service guarantees of WSN protocols and security protocols.

CO3: Write programming for WSN using hardware and software platforms.

CO, PO MAPPING

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

Sensors and Actuators

Semester VII **Hours of Instruction/week: 3**
21MEIE03/ 21BELE28 **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. Doeblin, "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.

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

COs/ 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

IoT Architecture and Standards

Semester VII **Hours of Instruction/Week: 3T**
21MEIE04 / 21BELE27 **No. of Credits: 3**

Prerequisite: Fundamentals of IoT, Operating Systems, Wireless Networks

Objective:

CLO1: To obtain systematic professional knowledge and strong practical skills in the IoT Platform and System Design.

Unit I IoT Networking Core 9

Technologies involved in IoT development, Internet web and Networking technologies, Infrastructure, Overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards, Wireless networking equipment and configurations, accessing hardware and device file interactions.

Unit II M2M to IoT 9

Role of M2M in IoT, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit III IoT Systems- Logical Design using Python 9

Language features of Python, Data types, data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling Python packages - JSON, XML, HTTPLib, URLLib, SMTPLib. IoT Physical Devices and Endpoints – Basic building blocks of an IoT device Exemplary Device: Raspberry Pi, about the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python.

Unit IV IoT Application Development 9

Application protocols: MQTT, REST/HTTP, CoAP, MySQL, Back-end Application Designing Apache for handling HTTP Requests, MongoDB Object type Database, HTML, CSS &jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development.

Unit V Case Studies 9

Home Automation, smart cities, Smart Grid, Electric vehicle charging, Environment, Agriculture, Productivity Applications.

Total Hours: 45

Reference Books:

1. ***ArshdeepBahga and VijaiMadisetti, "A Hands-on Approach "Internet of Things",*** Universities Press, 2015.
2. ***Gastón C. Hillar, "Internet of Things with Python",*** Packt Publishing Ltd. Livery Place 35 Livery Street Birmingham B3 2PB, UK.
3. ***Samuel Greengard, " The Internet of Things",*** The MIT press, 2015.

4. ***Adrian McEwen and Hakim Cassimally" Designing the Internet of Things",*** Wiley, 2014.
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. OvidiuVermesan, 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

COs/ 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

Data Mining

Semester VII **Hours of Instruction/week: 3T**
21MEIE05 / 21BELE31 **No. of Credits: 3**

Prerequisite: Data Structures

Objectives:

CLO1: Familiarize the need for applying data mining methods in various domains to solve real world problem.

CLO2: Apply association rule mining, classification and clustering techniques for mining knowledge from a data warehouse.

Unit I Introduction **9**

Introduction to Data Mining, Data Mining, Kinds of Data to be Mined, Kinds of Patterns to be Mined – Technologies Used – Applications – Issues in Data Mining – Getting to know the Data –Data Objects and Attribute Types – Basic Statistical Descriptions of Data – Data Visualization – Measuring Data Similarity and Dissimilarity.

Unit II Data Pre-processing and Data Warehousing **9**

Data Pre-processing – An Overview – Data Cleaning – Data Integration – Data Reduction – Data Transformation and Data Discretization – Data Warehouse: Basic Concepts – Data Warehouse Modelling: Data Cube and OLAP – Data Warehouse Design and Usage – Data Warehouse Implementation – Data Generalization by Attribute-Oriented Induction.

Unit III Frequent Patterns- Associations- Correlations and Classifications **9**

Mining Frequent Patterns- Associations- and Correlations: Basic Concepts – Frequent Itemset Mining Methods – Pattern Evaluation Methods – Classification: Basic Concepts – Decision Tree Induction – Bayes Classification Methods – Rule Based Classification – Model Evaluation and Selection – Techniques to Improve Classification Accuracy.

Unit IV Classification and Cluster Analysis **9**

Classification: Advanced Methods – Bayesian Belief Networks – Classification by Back-propagation – Support Vector Machines – Classification Using Frequent Patterns – Lazy Learners – Other Classification Methods – Multiclass Classification – Semi-Supervised Classification – Active Learning – Transfer Learning – Cluster Analysis: Basic Concepts – Partitioning Methods – Hierarchical Methods – Density Based Methods – Grid Based Methods – Evaluation of Clustering – Probabilistic Model-Based Clustering.

Unit V Outlier Detection **9**

Outlier Detection: Basic Concepts – Outlier Detection Methods – Statistical Approaches – Proximity Based Approaches – Clustering Based Approaches – Classification Based Approaches – Mining Contextual and Collective Outliers – Outlier Detection in High Dimensional Data.

Total Hours: 45

Reference Books:

1. ***Jiawei Han and MichaelineKamber, "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

5G Communication in IoT

Semester VII **Hours of Instruction/week: 3T**
21MEIE06 / 21BELE29 **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, Ratinale 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. ***AfifOsseiran, 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 PramodViswanath, "Fundamentals of Wireless Communication",*** Cambridge University Press, 2010.
6. ***Jonathan Rodriquez, "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 ForIoT 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

Printed and Wearable Electronics

Semester VII **Hours of Instruction/week: 3T**
21MEIE07 / 21BELE24 **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 - PhotoPlethysmography (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, NripenChanda, 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 VII **Hours of Instruction/week: 3T**
21MEIE08 / 21BELE25 **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 RTOSScheduling 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. ***VenkateswaranSreekrishnan****, **"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 17the 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 freeRTOS 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									

Queuing Theory

Semester VII **Hours of Instruction/week: 3T**
21MEIE09 / 21BELE32 **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 – PollaczekKhinchin 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 Jersy, 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 analyzingqueueing 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		

Robotics and Machine Vision

Semester VIII **Hours of Instruction/Week: 4T**
21MEIE10 **No. of Credits: 4**

Prerequisite: Electronic Circuits, Consumer Electronics, Programming with Raspberry pi

Objectives:

CLO1: To familiarize the functions and the basic components of a Robots and Sensors.

CLO2: Gain knowledge in Robot Kinematics, Programming and Machine Vision.

Unit I Fundamentals of Robot **12**

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load-Robot Parts and their Functions-Need for Robots-Different Applications.

Unit II Robot Drive Systems and End Effectors **12**

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

Unit III Kinematics and Robot Perception **12**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Sensors for mobile robots – vision for robotics – cameras – image formation – structure from stereo – structure from motion – optical flow – color tracking – place recognition – range data

Unit IV Robot Programming **12**

Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effectors commands and simple Programs.

Unit V Machine Vision Fundamentals **12**

Image acquisition, digital images- Sampling and Quantization- Levels of computation-Feature extraction- Windowing technique-segmentation- Thresholding- Edge detection- Binary morphology- Grey morphology

Total Hours: 60

Reference Books:

1. ***Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach",*** Prentice Hall, 2003.
2. ***Groover M.P., "Industrial Robotics -Technology Programming and Applications",*** McGraw Hill, 2001.
3. ***Craig J.J., "Introduction to Robotics Mechanics and Control",*** Pearson Education, 2008.
4. ***Deb S.R., "Robotics Technology and Flexible Automation"*** Tata McGraw Hill Book Co., 1994.
5. ***Koren Y., "Robotics for Engineers",*** McGraw-Hill Book Co., 1992.
6. ***Fu.K.S., Gonzalz R.C. and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence",*** McGraw Hill Book Co., 1987.
7. ***Janakiraman P.A., "Robotics and Image Processing",*** Tata McGraw Hill, 1995.
8. ***Rajput R.K., "Robotics and Industrial Automation",*** S.Chand and Company, 2008.
9. ***Surender Kumar, "Industrial Robots and Computer Integrated Manufacturing",*** Oxford and IBH Publishing Co. Pvt. Ltd., 1991.

Course Outcomes:

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

CO1: Apply the basic engineering knowledge for the design of robotics

CO2: Utilize the gained knowledge about sensors and programming

CO3: Understand the concepts of Machine Vision.

CO, PO MAPPING

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

Big Data and Cloud Computing

Semester VIII **Hours of Instruction/week: 4T**
21MEIE11 **No. of Credits: 4**

Prerequisite: Java, Data Mining

Objectives:

CLO1: Learn the basics of big data, cloud architecture and their real-world applications.

CLO2: Analyse big data using machine learning techniques through R programming.

Unit I Introduction to Big Data 12

Introduction to Big Data Platform - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Statistical Concepts - Streams Concepts- Stream Data Model and Architecture - Sampling Data in a Stream-Counting Distinct Elements in a Stream.

Unit II Data Analytics with R 12

Machine Learning: Introduction, Supervised Learning, Unsupervised Learning- Collaborative Filtering - Big Data Analytics with R programming.

Unit III Hadoop Environment 12

History of Hadoop, Apache Hadoop, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Distributed File System – Components of Hadoop - Analyzing the Data with Hadoop- Hadoop Streaming- Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives

Unit IV Cloud Architecture 12

Technologies for Network-Based System – System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture. Cloud Models: Characteristics– Cloud Services – Cloud models– Public vs Private Cloud – Cloud Solutions– Service management. Architectural Design of Compute and Storage Clouds – Layered Cloud Architecture-Development – Design Challenges.

Unit V Frameworks and Applications 12

IBM for Big Data –Framework – Hive- Impala – Analyzing big data with twitter – Big data for Ecommerce – Big data for blogs. Google App Engine, Amazon AWS - Cloud Software Environments -Eucalyptus, Open Nebula, CloudSim.

Total Hours: 60

Reference Books:

1. ***Seema Acharya, Subhasini Chellappan, "Big Data Analytics",*** Wiley 2015.
2. ***Jay Liebowitz, "Big Data and Business Analytics",*** Auerbach Publications, CRC press,2013.
3. ***Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop",*** McGraw-Hill/Osborne Media, 2013, Oracle press.
4. ***Tom White "Hadoop: The Definitive Guide",*** Third Edit on, O'reily Media, 2012.
5. ***John W.Ritting house and James F.Ransome, "Cloud Computing: Implementation, Management, and Security",*** CRC Press, 2010.

Course Outcomes:

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

CO1: Understand the big data platform and analyze the analytic techniques useful for business applications.

CO2: Analyze the Hadoop Environment associated with big data analytics.

CO3: Identify the architecture, infrastructure and delivery models of cloud computing.

CO, PO MAPPING

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

Industry 4.0 and Industrial IoT

Semester VIII **Hours of Instruction/week: 4T**
21MEIE12 **No. of Credits: 4**

Prerequisites: Internet of Things (IoT)

Objectives:

CLO1: Introduce how IIoT has become a game changer in the new economy.

CLO2: Introduce the tools and techniques that enable IIoT solution and Security aspects.

Unit I Industry 4.0 12

Need – Reason for Adopting Industry 4.0 - Definition – Goals and Design Principles - LEAN Production Systems - Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Technologies in Industry 4.0 - Cybersecurity, Augmented Reality and Virtual Reality, Introduction to FDM machine.

Unit II Industrial IoT 12

Introduction, Industrial processes, Industrial sensing & Actuation - Business Model and Reference Architecture – Layers - IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking, Industrial Internet of Things and Cyber Manufacturing Systems, Application map for Industrial Cyber Physical Systems

Unit III IIoT Analytics 12

Big Data: Characteristics of Industrial Big Data, Time-Series Data and its importance in industry - Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

Unit IV IIoT Security 12

IIoT Security Challenges - Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT, System Integration and Interoperability, Standards and Frameworks: ISA-95, RAMI 4.0.

Unit V Case Study 12

IIoT Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Smart Metering, e-Health & Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Milk Processing and Packaging Industries, Manufacturing Industries.

Total Hours: 60

Reference Books:

1. ***Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things",*** Apress, 2016.
2. ***Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber Manufacturing Systems",*** Springer, 2017.
3. ***Giacomo Veneri, Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT",*** Packt, 2018.
4. ***Red Lion, "How Protocol Conversion Addresses IIoT Challenges",*** White Paper.

Course Outcomes:

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

CO1: Outline the basic concepts and technologies of Industry 4.0.

CO2: Explore key IIoT concepts including sensors, processing, wireless protocols, data storage and security.

CO3: Understand various IIoT Layers, technologies, analytics and 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	L		M	M		
CO2	H	M	M	M	L	L	L		M	M		
CO3	H	M	M	M	L	L	L		M	M		

Modbus Protocols and Programming

Semester VIII **Hours of Instruction/Week: 4T**
21MEIE13 **No. of Credits: 4**

Prerequisite: Computer Networks, Embedded Systems

Objective:

CLO1: To understand the communication between devices.

Unit I Introduction 12

LRC generation – CRC generation – Read commands structure -Write commands structure – Exception codes – Register Tables – Register set 0 & 1

Unit II Modbus Protocol 12

Introducing Modbus Protocol - Two Serial Transmission Modes: ASCII Mode, RTU Mode - Modbus Message Framing - Error Checking Methods: Parity Checking, LRC Checking, CRC Checking

Unit III Data and Control Functions 12

Modbus Function Formats – Function codes supported by controllers: Read coil status, Read Input Status, Read Holding Registers, Read Input registers, Force Single Coil, Preset Single Register, Read Exception Status, Fetch communication control, Mask, Read/Write 4X Registers, Read FIFO Queue

Unit IV Diagnostic Subfunctions 12

Diagnostics – Diagnostics codes supported by controllers – Diagnostic Sub-functions: Return Query data, Restart communication option, Return diagnostic register, Change ASCII Input Delimiter, Force listen only mode and use Hex codes for count operations

Unit V Modbus in LabVIEW 12

LabVIEW Real-Time Module: High Level OPC Server – Modbus I/O Server – LabVIEW Modbus API

Total Hours: 60

Reference Books:

1. ***"MODBUS communication protocol",*** Enerdis Chauvin Arnoux Group, October 2014.
2. ***"Modicon Modbus Protocol Reference Guide",*** MODICON, Inc., Industrial Automation Systems, June 1996.
3. ***"Modbus Basics: Camille Bauer AG"***.

Course Outcomes:

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

CO1: Comprehend the basics of Modbus and the generation of CRC and LRC.

CO2: Apply the Data, Control and Diagnostics commands in real-time applications.

CO3: Perform analysis using LabVIEW.

CO, PO MAPPING

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

Parallel and Distributed Computing

Semester VIII **Hours of Instruction/week: 4T**
21MEIE14 **No. of Credits: 4**

Prerequisite: Computer Networks, Computer System Architecture

Objectives:

CLO1: Understand the need and fundamentals of parallel computing paradigms.
CLO2: Learn the programming principles in parallel and distributed computing.

Unit I Introduction to Parallel Computing 12

Scope of Parallel Computing – Parallel Programming Platforms – Implicit Parallelism – Limitations of Memory System Performance – Control Structure of Parallel Platforms – Communication Model of Parallel Platforms – Physical Organization of Parallel Platforms – Communication Costs in Parallel Machines – Impact of Process - Processor Mapping and Mapping Techniques.

Unit II Parallel Algorithm Design 12

Preliminaries – Decomposition Techniques – Characteristics of Tasks and Interactions – Mapping Techniques for Load Balancing – Methods for Containing Interaction Overheads – Parallel Algorithm Models – Basic Communication Operations – One-to-All Broadcast and All-to-One Reduction – All-to-All Broadcast and Reduction – All-Reduce and Prefix Sum Operations – Scatter and Gather – All-to-All Personalized Communication- Circular Shift – Improving the Speed of some Communication Operations.

Unit III Programming Using Message Passing and Shared Address Space 12

Principles of Message Passing Programming – Building Blocks – Send and Receive Operations – MPI – Message Passing Interface – Topologies and Embedding – Overlapping Communication with Computation – Collective Communication and Computation Operations – Groups and Communicators – POSIX thread API – OpenMP: a Standard for Directive based Parallel Programming – Applications of Parallel Programming - Matrix-Matrix Multiplication – Solving Systems of Equations – Sorting Networks - Bubble Sort Variations – Parallel Depth First Search.

Unit IV Distributed Computing Paradigm 12

Paradigms for Distributed applications – Basic algorithms in Message passing Systems – Leader Election in Rings – Mutual Exclusion in Shared Memory.

Unit V Fault Tolerant Design 12

Synchronous Systems with Crash Failures – Byzantine Failures – Impossibility in Asynchronous Systems - Formal Model for Simulation – Broadcast and Multicast – Specification of a Broadcast Service – Implementing a Broadcast Service – Multicast in Groups – Distributed Shared Memory– Linearizable – Sequentially Consistent Shared Memory – Algorithms.

Total Hours: 60

Reference Books:

1. ***Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, "Introduction to Parallel Computing",*** Second Edition, Pearson Education, 2009.
2. ***Haggit Attiya and Jennifer Welch, "Distributed Computing Fundamentals, Simulations and Advanced Topics",*** Second Edition, Wiley, 2012.
3. ***Michael Quinn, "Parallel Computing Theory and Practice",*** Second Edition, Tata McGraw Hill, 2002.
4. ***Norman Matloff, "Parallel Computing for Data Science with Examples in R, C++ and CUDA",*** Chapman and Hall/CRC, 2015.
5. ***Wan Fokkink, "Distributed Algorithms: An Intuitive Approach",*** MIT Press, 2013.
6. ***M.L. Liu, "Distributed Computing Principles and Applications",*** First Edition, Pearson Education, 2011.

Course Outcomes:

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

CO1: Apply problem solving skills to distributed applications

CO2: Develop applications by incorporating parallel and distributed computing architectures

CO3: Develop applications by incorporating fault tolerance and converting sequential algorithm to a parallel.

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

High Speed Networks

Semester VIII **Hours of Instruction/week: 4T**
21MEIE15 **No. of Credits: 4**

Prerequisite: Computer Networks

Objectives:

CLO1: Familiarize the concepts of ATM, congestion control and traffic management systems.

CLO2: Analyze the categories of protocols and apply in projects involving any of the high- speed networking technologies.

Unit I High Speed Networks 12

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL, High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LANs: applications, requirements – Architecture of 802.11.

Unit II Congestion and Traffic Management 12

Queuing Analysis- Queuing Models – Single Server Queues – Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

Unit III TCP and ATM Congestion Control 12

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO backoff – KARN's Algorithm – Window management – Performance of TCP over ATM. Traffic and Congestion control in ATM – Requirements – Attributes – Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.

Unit IV Integrated and Differentiated Services 12

Integrated Services Architecture – Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ – Random Early Detection, Differentiated Services.

Unit V Protocols for QoS Support 12

RSVP – Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms – Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP – Protocol Architecture, Data Transfer Protocol, RTCP.

Total Hours: 60

Reference Books:

1. ***William Stallings, "High Speed Networks and Internet",*** 2nd edition, Pearson Education, 2002.
2. ***Harry Perros, "High Performance Communication Networks",*** Springer, 2012.

3. ***Abhijit S. Pandya, Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks",*** CRC Press, New York, 2004.

Course Outcomes:

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

CO1: Illustrate the concepts of ATM and Frame relay and solve problems involving congestion control and traffic management.

CO2: Analyze the protocols employed in connection-oriented services and incorporate the concepts of integrated and differentiated Services in various applications.

CO3: Discuss the applicability of various levels of quality of service (QoS) in real world scenario.

CO, PO MAPPING

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