



VIT[®]

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING

B. Tech Electronics and Communication Engineering

Curriculum and Syllabus

(2024-25 admitted students)

B. Tech Electronics and Communication Engineering

INSTITUTE VISION

Transforming life through excellence in education and research.

INSTITUTE MISSION

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

SCHOOL VISION

To be a leader in imparting in-depth and futuristic knowledge of electronics engineering and allied domains that cater to the needs of industry, research, and society.

SCHOOL MISSION

- **M1:** To create and maintain an environment of excellence in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines.
- **M2:** To collaborate with industries and universities in associated disciplines to pioneer in innovations and technology transfer.
- **M3:** To equip students with the necessary knowledge and research skills enabling them to be lifelong learners in solving real-life problems, thereby improving the quality of human life and values

B. Tech Electronics and Communication Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates will exhibit competencies in Electronics and Communication Engineering by applying scientific principles and modern practices to solve complex engineering problems.

PEO2: Graduates will excel as Electronics and Communication Engineering professionals; innovators engaged in sustainable technology development in industry/ entrepreneurs/ pursue higher studies.

PEO3: Graduates will work in multi-disciplinary teams as responsible professionals, contributing effectively to the development of society.

PROGRAMME OUTCOMES (POs)

PO_01. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO_02. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO_03. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO_04. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO_05. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO_06. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO_07. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO_08. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO_09. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO_10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO_11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO_12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

B. Tech Electronics and Communication Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On the completion of B. Tech Electronics and Communication Engineering degree, Students will be able to

PSO1 - Apply state-of-the-art methodologies and tools to model integrated circuits to meet the demands of modern electronic systems.

PSO2 - Analyse signal processing techniques, RF and optical technologies to implement intelligent communication systems and networks that meet the demands of rapidly evolving digital landscape.

PSO3 - Develop embedded solutions using cutting-edge technologies and tools to satisfy the requirement of smart applications and next-generation networks.

B. Tech Electronics and Communication Engineering

CREDIT STRUCTURE

Curriculum Component	Credits
Basic Sciences	26
Basic Engineering	15
Humanities and Social Sciences	19
Program Core	63
Program Electives	15
Open Electives	15
Project(s)	8
Internships/Seminars	1
Total Graded Credit Requirement	162

B. Tech Electronics and Communication Engineering

No	Course Code	Course Title	L	T	P	C
Basic Sciences						
1	BPHY101L	Engineering Physics	3	0	0	3
2	BPHY101P	Engineering Physics Lab	0	0	2	1
3	BCHY101L	Engineering Chemistry	3	0	0	3
4	BCHY101P	Engineering Chemistry Lab	0	0	2	1
5	BMAT101L	Calculus	3	0	0	3
6	BMAT101P	Calculus Lab	0	0	2	1
7	BMAT102L	Differential Equations and Transforms	3	1	0	4
8	BMAT201L	Complex Variables and Linear Algebra	3	1	0	4
9	BMAT202L	Probability and Statistics	3	0	0	3
10	BMAT202L	Probability and Statistics Lab	0	0	2	1
11	BCHY102N	Environmental Sciences	0	0	0	2
Basic Engineering						
12	BEEE102L	Basic Electrical and Electronics Engineering	3	0	0	3
13	BEEE102P	Basic Electrical and Electronics Engineering Lab	0	0	2	1
14	BCSE101E	Computer Programming: Python	1	0	4	3
15	BCSE103E	Computer Programming: Java	1	0	4	3
16	BECE101N	Introduction to Engineering	0	0	0	1
17	BSSC101N	Essence of Traditional Knowledge	0	0	0	2
18	BEXC100N	Extracurricular Activities	0	0	0	2
Humanities and Social Sciences						
19	BENG101N	Effective English Communication (NGC)	0	0	4	2
20	BENG101L	Technical English Communication	2	0	0	2
21	BENG101P	Technical English Communication Lab	0	0	2	1

22	BENG102P	Technical Report Writing	0	0	2	1
23	BSTS101P	Quantitative Skills Practice I	0	0	3	1.5
24	BSTS102P	Quantitative Skills Practice II	0	0	3	1.5
25	BSTS201P	Qualitative Skills Practice I	0	0	3	1.5
26	BSTS202P	Qualitative Skills Practice II	0	0	3	1.5
27	BFLE200L	Foreign Language	2	0	0	2
28	BHSM200L	HSM Elective	3	0	0	3
29	BSSC102N	Indian Constitution	0	0	0	2
30	BHUM101N	Ethics and Values	0	0	0	2

Foreign Language

No	Course Code	Course Title	L	T	P	C
1	BARB101L	Arabic	2	0	0	2
2	BCHI101L	Chinese I	2	0	0	2
3	BESP101L	Spanish I	2	0	0	2
4	BFRE101L	French I	2	0	0	2
5	BGER101L	German I	2	0	0	2
6	BGRE101L	Modern Greek	2	0	0	2
7	BITL101L	Italian	2	0	0	2
8	BJAP101L	Japanese I	2	0	0	2
9	BKOR101L	Basic Korean – Level 1	2	0	0	2
10	BKOR102L	Basic Korean – Level 2	2	0	0	2

HSM Elective

No	Course Code	Course Title	L	T	P	C
1	BHUM102E	Indian Classical Music	3	0	0	3
2	BHUM103L	Micro Economics	3	0	0	3
3	BHUM104L	Macro Economics	3	0	0	3
4	BHUM105L	Public Policy and Administration	3	0	0	3
5	BHUM106L	Principles of Sociology	3	0	0	3
6	BHUM107L	Sustainability and Society	3	0	0	3
7	BHUM108L	Urban Community Development	3	0	0	3
8	BHUM109L	Social Work and Sustainability	3	0	0	3
9	BHUM110E	Cognitive Psychology	3	0	0	3
10	BMGT101L	Principles of Management	3	0	0	3
11	BMGT102L	Human Resource Management	3	0	0	3
12	BMGT103L	Organizational Behavior	3	0	0	3
13	BMGT104L	Marketing Management	3	0	0	3
14	BMGT105L	Consumer Behavior	3	0	0	3
15	BMGT106L	Digital Marketing	3	0	0	3
16	BMGT107L	Business Analytics	3	0	0	3
17	BCLE214L	Global Warming	3	0	0	3
18	BCLE215L	Waste Management	3	0	0	3
19	BCLE216L	Water Resources Management	3	0	0	3

Discipline Core Courses

No.	Course Code	Course Title	L	T	P	C	Pre-Requisite
1.	BECE201L	Electronic Materials and Devices	3	0	0	3	NIL
2.	BECE202L	Signals and Systems	2	1	0	3	BMAT102
3.	BECE203L	Circuit Theory	3	1	0	4	BEEE101L, BEEE101P
4.	BECE102L	Digital Systems Design	3	0	0	3	NIL
5.	BECE102P	Digital Systems Design Lab	0	0	2	1	NIL
6.	BECE204L	Microprocessors and Microcontrollers	3	0	0	3	BECE102L
7.	BECE204P	Microprocessors and Microcontrollers Lab	0	0	2	1	BECE102L
8.	BECE205L	Engineering Electromagnetics	3	0	0	3	BPHY101L, BPHY101P
9.	BECE206L	Analog Circuits	3	0	0	3	BECE201L
10.	BECE206P	Analog Circuits Lab	0	0	2	1	BECE201L
11.	BECE207L	Random Processes	2	1	0	3	BMAT202L, BMAT202P, BECE202L
12.	BECE301L	Digital Signal Processing	3	0	0	3	BECE202L
13.	BECE301P	Digital Signal Processing Lab	0	0	2	1	BECE202L
14.	BECE302L	Control Systems	2	1	0	3	BECE202L
15.	BECE303L	VLSI System Design	3	0	0	3	BECE204L, BECE204P
16.	BECE303P	VLSI System Design Lab	0	0	2	1	BECE204L, BECE204P

17.	BECE304L	Analog Communication Systems	3	0	0	3	BECE206L, BECE206P
18.	BECE304P	Analog Communication Systems Lab	0	0	2	1	BECE206L, BECE206P
19.	BECE305L	Antenna and Microwave Engineering	3	0	0	3	BECE205L
20.	BECE305P	Antenna and Microwave Engineering Lab	0	0	2	1	BECE205L
21.	BECE306L	Digital Communication Systems	3	0	0	3	BECE206L, BECE206P
22.	BECE306P	Digital Communication Systems Lab	0	0	2	1	BECE206L, BECE206P
23.	BECE317L	Wireless and Mobile Communications	3	0	0	3	BECE306L, BECE306P
24.	BECE317P	Wireless and Mobile Communications Lab	0	0	2	1	BECE306L, BECE306P
25.	BECE318L	Optical Fiber Communications	3	0	0	3	BECE306L, BECE306P
26.	BECE318P	Optical Fiber Communications Lab	0	0	2	1	BECE306L, BECE306P
27.	BECE401L	Computer Communications and Networks	3	0	0	3	BECE306L, BECE306P
28.	BECE401P	Computer Communications and Networks Lab	0	0	2	1	BECE306L, BECE306P

Discipline Elective Courses

No.	Course Code	Course Title	L	T	P	C	Pre-Requisite
1	BECE208E	Data Structures and Algorithms	2	0	2	3	BCSE101E
2	BECE209E	Structured and Object Oriented Programming	2	0	4	4	NIL
3	BECE309L	Artificial Intelligence and Machine Learning	3	0	0	3	BMAT201L
4	BECE310L	Satellite Communications	3	0	0	3	BECE306L, BECE306P
5	BECE311L	Radar Systems	3	0	0	3	BECE305L, BECE305P
6	BECE312L	Robotics and Automation	3	0	0	3	NIL
7	BECE313L	Information Theory and Coding	3	0	0	3	BECE306L, BECE306P
8	BECE314L	Electromagnetic Interference and Compatibility	2	1	0	3	BECE205L
9	BECE315L	Optical Networks	3	0	0	3	BECE318L, BECE318P
10	BECE316E	Digital Image Processing	3	0	2	4	BECE301L, BECE301P
11	BECE320E	Embedded C Programming	2	0	2	3	NIL
12	BECE403E	Embedded Systems Design	3	0	2	4	BECE204L, BECE204P
13	BECE404L	Detection, Estimation and Modulation Theory	3	0	0	3	BECE207L
14	BECE405L	Cognitive Radio Networks	3	0	0	3	BECE317L, BECE317P
15	BECE406E	FPGA Based System Design	2	0	2	3	BECE102L, BECE102P
16	BECE407E	ASIC Design	2	0	2	3	BECE303L, BECE303P

17	BECE408L	Microwave Integrated Circuits	3	0	0	3	BECE305L, BECE305P
18	BECE409E	Sensors Technology	2	0	2	3	NIL
19	BECE410L	Micro-Electromechanical Systems	3	0	0	3	NIL
20	BECE411L	Cryptography and Network Security	3	0	0	3	BECE401L, BECE401P
21	BECE391J	Technical Answers to Real Problems Project	0	0	6	3	NIL
22	BECE392J	Design Project	0	0	6	3	NIL
23	BECE393J	Laboratory Project	0	0	6	3	NIL
24	BECE394J	Product Development Project	0	0	6	3	NIL
25	BECE395J	Computer Project	0	0	6	3	NIL
26	BECE396J	Reading Course	0	0	6	3	NIL
27	BECE397J	Special Project	0	0	6	3	NIL
28	BECE398J	Simulation Project	0	0	6	3	NIL

Open Elective Courses

No.	Course Code	Course Title	L	T	P	C	Pre-Requisite
1	BHUM201L	Mass Communication	3	0	0	3	NIL
2	BHUM202L	Rural Development	3	0	0	3	NIL
3	BHUM203L	Introduction to Psychology	3	0	0	3	NIL
4	BHUM204L	Industrial Psychology	3	0	0	3	NIL
5	BHUM205L	Development Economics	3	0	0	3	NIL
6	BHUM206L	International Economics	3	0	0	3	NIL
7	BHUM207L	Engineering Economics	3	0	0	3	NIL
8	BHUM208L	Economics of Strategy	3	0	0	3	NIL
9	BHUM209L	Game Theory	3	0	0	3	NIL
10	BHUM210E	Econometrics	3	0	0	3	NIL

11	BHUM211L	Behavioral Economics	3	0	0	3	NIL
12	BHUM212L	Mathematics for Economic Analysis	3	0	0	3	NIL
13	BHUM213L	Corporate Social Responsibility	3	0	0	3	NIL
14	BHUM214L	Political Science	3	0	0	3	NIL
15	BHUM215L	International Relations	3	0	0	3	NIL
16	BHUM216L	Indian Culture and Heritage	3	0	0	3	NIL
17	BHUM217L	Contemporary India	3	0	0	3	NIL
18	BHUM218L	Financial Management	3	0	0	3	NIL
19	BHUM219L	Principles of Accounting	3	0	0	3	NIL
20	BHUM220L	Financial Markets and Institutions	3	0	0	3	NIL
21	BHUM221L	Economics of Money, Banking and Financial Markets	3	0	0	3	NIL
22	BHUM222L	Security Analysis and Portfolio Management	3	0	0	3	NIL
23	BHUM223L	Options, Futures and other Derivatives	3	0	0	3	NIL
24	BHUM224L	Fixed Income Securities	3	0	0	3	NIL
25	BHUM225L	Personal Finance	3	0	0	3	NIL
26	BHUM226L	Corporate Finance	3	0	0	3	NIL
26	BHUM227L	Financial Statement Analysis	3	0	0	3	NIL
28	BHUM228L	Cost and Management Accounting	3	0	0	3	NIL
29	BSTS301P	Advanced Competitive Coding – I	0	0	3	1.5	NIL
30	BSTS302P	Advanced Competitive Coding – II	0	0	3	1.5	NIL
31	BECE355L	AWS for Cloud Computing	3	0	2	3	NIL

Project and Internship

No.	Course Code	Course Title	L	T	P	C
1	BECE399J	Summer Industrial Internship	0	0	2	1
2	BECE497J	Project-I	0	0	6	3
3	BECE498J	Project-II / Internship	0	0	10	5
4	BECE499J	One Semester Internship	0	0	28	14

Course Code	Course Title	L	T	P	C
BPHY101L	Engineering Physics	3	0	0	3
Pre-requisite	12 th of equivalent	Syllabus version			
		1.0			
Course Objectives					
1. To explain the dual nature of radiation and matter. 2. To apply Schrödinger’s equation to solve finite and infinite potential problems and apply quantum ideas at the nanoscale. 3. To understand the Maxwell’s equations for electromagnetic waves and apply the concepts to semiconductors for engineering applications.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Apply Newtonian mechanics to model the waves in an elastic medium. 2. Interpret the properties of electromagnetic waves using the Maxwell's equations. 3. Apply quantum mechanical ideas to microscopic systems. 4. Employ Einstein's theory of stimulated emission to examine the characteristics and working of lasers. 5. Articulate the primary components of a typical optical fiber communications system and their working principles.					
Module:1	Introduction to waves	7 hours			
Waves on a string - Wave equation on a string (derivation) - Harmonic waves- reflection and transmission of waves at a boundary - Standing waves and their eigenfrequencies - waves with dispersion - Superposition of waves and Fourier method (qualitative) - Wave packet - phase velocity and group velocity.					
Module:2	Electromagnetic waves	7 hours			
Physics of divergence - gradient and curl - surface and volume integral - Maxwell Equations (Qualitative) - Continuity equation for current densities - Displacement current - Electromagnetic wave equation in free space - Plane electromagnetic waves in free space - Hertz’s experiment.					
Module:3	Elements of quantum mechanics	7 hours			
Need for Quantum Mechanics: Idea of Quantization (Planck and Einstein) - Compton effect (Qualitative) — de Broglie hypothesis - justification of Bohr postulate - Davisson-Germer experiment - Wave function and probability interpretation - Heisenberg uncertainty principle - Gedanken experiment (Heisenberg’s microscope) - Schrödinger wave equation (time dependent and time independent).					
Module:4	Applications of quantum mechanics	6 hours			
Eigenvalues and eigenfunction of particle confined in one-dimensional box - Basics of nanophysics - Quantum confinement and nanostructures - Tunnel effect (qualitative) and scanning tunneling microscope.					
Module:5	Lasers	6 hours			
Laser characteristics - spatial and temporal coherence - Einstein coefficients and their significance - Population inversion - two, three and four level systems - Pumping schemes - threshold gain coefficient - Components of a laser - He-Ne, Nd: YAG and CO ₂ lasers and their engineering applications.					
Module:6	Propagation of EM waves in optical fibers	5 hours			
Introduction to optical fiber communication system - light propagation through fibers - Acceptance angle - Numerical aperture - V-parameter - Types of fibers — Attenuation - Dispersion-intermodal and intramodal. Application of fiber in medicine - Endoscopy.					
Module:7	Optoelectronic devices	5 hours			
Introduction to semiconductors - direct and indirect bandgap — p-n junction, Sources: LED and laser diode, Photodetectors: PN and PIN					

Course Code	Course Title	L	T	P	C
BPHY101P	Engineering Physics Lab	0	0	2	1
Pre-requisite	12 th or equivalent	Syllabus version			
		1.0			
Course Objectives					
To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Analyse the idea of quantization through quantum mechanical experiments					
2. Demonstrate the quantum mechanical ideas in microscopic domain.					
3. Demonstrate the applications of optoelectronic devices in optical fiber communication.					
Indicative Experiments					
1.	To determine the dependence of fundamental frequency with the length and tension of a stretched string using sonometer.				
2.	To determine the characteristics of EM waves using Hertz experiment				
3.	To determine the wavelength of laser source (He-Ne laser and diode lasers of different wavelengths) using diffraction grating				
4.	To demonstrate the wave nature of electron by diffraction through graphite sheet				
5.	To determine the Planck's constant using electroluminescence process				
6.	To numerically demonstrate the discrete energy levels and the wavefunctions using Schrödinger equation (e.g., particle in a box problem can be given as an assignment)				
7.	To determine the refractive index of a prism using spectrometer (angle of prism will be given)				
8.	To determine the efficiency of a solar cell				
9.	To determine the acceptance angle and numerical aperture of an optical fiber				
10.	To demonstrate the phase velocity and group velocity (simulation)				
Total Laboratory Hours					30 hours
Mode of assessment: Continuous assessment / FAT / Oral examination					
Recommended by Board of Studies			26.06.2021		
Approved by Academic Council			No. 63	Date	23.09.2021

[illegible]

Course Code	Course Title	L	T	P	C
BCHY101L	Engineering Chemistry	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To enable students to have fundamental understanding of the basic concepts of different disciplines of chemistry. 2. To provide avenues for learning advanced concepts from school to university 3. To empower students with emerging concepts in applied chemistry to be useful in addressing societal needs 4. To integrate analytical and computational ability with experimental skills to create individuals competent in basic science and its by-product of its application. 5. To offer opportunities to create pathways for self-reliant in terms of knowledge and higher learning					
Course Outcomes:					
At the end of the course, the student will be able to:					
1. Apply the concepts of thermodynamics, chemical kinetics, coordination chemistry, organic reactions and intermediates. 2. Describe the working principles of energy storage devices. 3. Interpret the preparation methods of functional materials. 4. Apply spectroscopic, diffraction and microscopic techniques. 5. Illustrate the applications of water treatment, fuel combustion and corrosion protection methods.					
Module:1	Chemical thermodynamics and kinetics	6 hours			
Laws of thermodynamics - entropy change (selected processes) – spontaneity of a chemical reaction and Gibbs free energy - heat transfer; Kinetics - Concept of activation energy and energy barrier - Arrhenius equation- effect of catalysts (homo and heterogeneous) – Enzyme catalysis (Michaelis-Menten Mechanism).					
Module:2	Metal complexes and organometallics	6 hours			
Inorganic complexes - structure, bonding and application; Organometallics – introduction, stability, structure and applications of metal carbonyls, ferrocene and Grignard reagent; Metals in biology (hemoglobin, chlorophyll- structure and property).					
Module:3	Organic intermediates and reaction transformations	6 hours			
Organic intermediates - stability and structure of carbocations, carbanions and radicals; Aromatics (aromaticity) and heterocycles (3, 4, 5, 6 membered and fused systems); Organic transformations for making useful drugs for specific disease targets (two examples) and dyes (addition, elimination, substitution and cross coupling reactions).					
Module:4	Energy devices	6 hours			
Electrochemical and electrolytic cells — electrode materials with examples (semi-conductors), electrode-electrolyte interface- chemistry of Li ion secondary batteries, supercapacitors; Fuel cells: H ₂ -O ₂ and solid oxide fuel cell (SOFC); Solar cells - photovoltaic cell (silicon based), photoelectrochemical cells and dye-sensitized cells.					
Module:5	Functional materials	7 hours			
Oxides of AB, AB ₂ , ABO ₃ type (specific examples); Composites - types and properties; Polymers - thermosetting and thermoplastic polymers – synthesis and application (TEFLON, BAKELITE); Conducting polymers- polyacetylene and effect of doping – chemistry of display devices specific to OLEDs; Nano materials – introduction, bulk vs nano (quantum dots), top-down and bottom-up approaches for synthesis, and properties of nano Au.					
Module:6	Spectroscopic, diffraction and microscopic techniques	5 hours			

Course Code	Course Title	L	T	P	C
BMAT101L	Calculus	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.					
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.					
3. Enhance to use technology to model the physical situations into mathematical problems, experiment, interpret results, and verify conclusions.					
Course Outcomes					
At the end of the course, the student will be able to:					
1. Solve problems involving single-variable differentiation and integration.					
2. Determine extrema of multivariable functions using partial derivatives and constrained optimization techniques.					
3. Calculate the areas and volumes using double and triple integrals in appropriate coordinate systems.					
4. Apply special functions to evaluate integrals occurring in mathematical and engineering applications.					
5. Solve problems involving scalar and vector fields using vector calculus concepts and integral theorems.					
Module:1	Single Variable Calculus	8 hours			
Differentiation- Extrema on an Interval Rolle’s Theorem and the Mean value theorem- Increasing and decreasing functions. -First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution.					
Module:2	Multivariable Calculus	5 hours			
Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.					
Module:3	Application of Multivariable Calculus	5 hours			
Taylor’s expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange’s multiplier method.					
Module:4	Multiple integrals	8 hours			
Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates.					
Module:5	Special Functions	6 hours			
Beta and Gamma functions–interrelation between beta and gamma functions-evaluation of multiple integrals using gamma and beta functions. Dirichlet’s integral -Error functions complementary error functions.					
Module:6	Vector Differentiation	5 hours			
Scalar and vector valued functions — gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials. Statement of vector identities-simple problems.					
Module:7	Vector Integration	6 hours			
Line, surface and volume integrals - Statement of Green’s, Stoke’s and Gauss divergence theorems - verification and evaluation of vector integrals using them.					
Module:8	Contemporary Topics	2 hours			
Guest lectures from Industry and, Research and Development Organizations					

Course Code	Course Title	L	T	P	C
BMAT101P	Calculus Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To familiarize with the basic syntax, semantics and library functions of MATLAB which serves as a tool not only in calculus but also many courses in engineering and sciences					
2. To visualize mathematical functions and its related properties.					
3. To evaluate single and multiple integrals and understand it graphically.					
Course Outcomes					
At the end of the course, the student will be able to:					
1. Solve calculus-based mathematical problems using MATLAB and represent the solutions graphically.					
2. Interpret graphical and numerical solutions of single-variable and multivariable calculus problems using MATLAB.					
Indicative Experiments					
1.	Introduction to MATLAB through matrices and general Syntax				
2.	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB				
3.	Evaluating Extremum of a single variable function				
4.	Understanding integration as Area under the curve				
5.	Evaluation of Volume by Integrals (Solids of Revolution)				
6.	Evaluating maxima and minima of functions of two variables				
7.	Applying Lagrange multiplier optimization method				
8.	Evaluating Volume under surfaces				
9.	Evaluating triple integrals				
10.	Evaluating gradient, curl and divergence				
11.	Evaluating line integrals in vectors				
12.	Applying Green's theorem to real world problems				
		Total Laboratory Hours		30 hours	
Text Book					
1.	Brian H. Hahn, Daniel T. Valentine, Essential MATLAB for Engineers and Scientists, Academic Press, 7th edition, 2019.				
Reference Books					
1.	Amos Gilat, MATLAB: An Introduction with Applications, Wiley, 6/e, 2016.				
2	Maritn Brokate, Pammy Manchanda, Abul Hasan Siddiqi, Calculus for Scientists and Engineers, Springer, 2019				
Mode of assessment: DA and FAT					
Recommended by Board of Studies		24.06.2021			
Approved by Academic Council		No. 63	Date	23.09.2021	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Solve calculus-based mathematical problems using MATLAB and represent the solutions graphically.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO2	Interpret graphical and numerical solutions of single-variable and multivariable calculus problems using MATLAB.	3	-	-	-	3	-	-	-	-	-	-	2	-	-	-

Course Code	Course Title	L	T	P	C
BMAT102L	Differential Equations and Transforms	3	1	0	4
Pre-requisite	BMAT101L, BMAT101P	Syllabus version			
		1.0			
Course Objectives					
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Course Code	Course Title	L	T	P	C
BMAT201L	Complex Variables and Linear Algebra	3	1	0	4
Pre-requisite	BMAT102L	Syllabus version			
		1.0			
Course Objectives					

Course Code	Course Title	L	T	P	C
BMAT202L	Probability and Statistics	3	0	0	3
Pre-requisite	BMAT101L, BMAT101P	Syllabus version			
		1.0			
Course Objectives:					
1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations. 2. To analyze distributions and relationship of real-time data. 3. To apply estimation and testing methods to make inference and modelling techniques for decision making.					
Course Outcome:					
At the end of the course, the student will be able to: 1. Compute descriptive measures of statistical data. 2. Apply suitable probability distributions to model random variables. 3. Determine relationships among variables using correlation and regression techniques. 4. Perform statistical estimation and hypothesis-testing procedures to draw inferences about population characteristics. 5. Employ statistical methods to solve reliability and maintainability problems in engineering systems.					
Module:1	Introduction to Statistics	6 hours			
Statistics and data analysis; Measures of central tendency; Measure of Dispersion, Moments-Skewness-Kurtosis (Concepts only).					
Module:2	Random variables	8 hours			
Random variables- Probability mass function, distribution and density functions-Joint probability distribution and Joint density functions; Marginal, Conditional distribution and Density functions-Mathematical expectation and its properties- Covariance, Moment generating function.					
Module:3	Correlation and Regression	4 hours			
Correlation and Regression — Rank Correlation; Partial and Multiple correlation; Multiple regression.					
Module:4	Probability Distributions	7 hours			
Binomial distribution; Poisson distributions; Normal distribution; Gamma distribution; Exponential distribution; Weibull distribution.					
Module:5	Hypothesis Testing-I	4 hours			
Testing of hypothesis –Types of errors - Critical region, Procedure for testing of hypothesis- large sample tests- Z test for Single Proportion- Difference of Proportion- Mean and difference of means.					
Module:6	Hypothesis Testing-II	9 hours			
Small sample tests- Student’s t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance — One Way-Two way-Three-way classifications - CRD-RBD- LSD.					
Module:7	Reliability	5 hours			
Basic concepts- Hazard Function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.					
Module:8	Contemporary Issues	2 hours			
Total lecture hours:					45 hours
Text Book					
1.	R. E. Walpole, R. H. Myers, S. L. Mayers, K. Ye, Probability and Statistics for engineers and scientists, 2012, 9 th Edition, Pearson Education.				
Reference Books					
1.	Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for				

Course Code	Course Title	L	T	P	C
BMAT202P	Probability and Statistics Lab	0	0	2	1
Pre-requisite	BMAT101L, BMAT101P	Syllabus version			
		1.0			
Course Objectives:					
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CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Interpret the graphical and statistical output of R programs to draw conclusions from experimental data.	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	Implement statistical computations - including descriptive statistics, probability distributions, correlation, regression, and hypothesis testing using R programming.	3	-	-	-	2	-	-	-	-	-	-	2	-	-	-

Course Code	Course Title	L	T	P	C
BEEE102L	Basic Electrical and Electronics Engineering	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Familiarize with various laws and theorems to solve electric and electronic circuits 2. Provide an overview on working principle of machines 3. Excel the concepts of semiconductor devices, op-amps and digital circuits					
Course Outcome					
At the end of the course, the student will be able to:					
1. Apply various electric circuit laws and theorems for electric circuit analysis 2. Determine the parameters of magnetic circuits 3. Explain the construction, working principles and applications of various types of electrical machines. 4. Design basic combinational circuits in digital system 5. Illustrate the characteristics and applications of semiconductor devices					
Module:1	DC Circuits	7 hours			
Basic circuit elements and sources; Ohms law; Kirchhoff’s laws; Series and Parallel connection of circuit elements; Star-delta transformation; Mesh current analysis; Node voltage analysis; Theorems: Thevenin's, Maximum power transfer and Superposition theorem.					
Module:2	AC Circuits	8 hours			
Alternating voltages and currents, RMS, average, maximum values, Single Phase RL, RC, RLC series circuits, Power in AC circuits, Power Factor, Three phase balanced systems, Star and delta Connections, Electrical Safety, Fuses and Earthing.					
Module:3	Magnetic Circuits	7 hours			
Magnetic field; Toroidal core: Flux density, Flux linkage; Magnetic circuit with airgap; Reluctance in series and parallel circuits; Self and mutual inductance; Transformer: turn ratio determination.					
Module:4	Electrical Machines	7 hours			
Construction, working principle and applications of DC Machines, Transformers, Three phase Induction motors, synchronous generators, single phase induction motors, special machines stepper motor, universal motor and BLDC motor.					
Module:5	Digital Systems	7 hours			
Binary arithmetic; Number base conversion; Boolean algebra: simplification of Boolean functions using K-maps; Logic gates; Design of basic combinational circuits: adders, multiplexers, de-multiplexers.					
Module: 6	Semiconductor Devices and Applications	7 hours			
Characteristics: PN junction diode, Zener diode, BJT, MOSFET; Applications: Rectifier, Voltage regulator, Operational amplifier.					
Module: 7	Contemporary Issues	2 hours			
Guest lectures from Industry and, Research and Development Organizations					
	Total Lecture hours:				45 hours
Text Book(s)					
1.	Allan R. Hambley, Electrical Engineering: Principles & Applications, 2019, 6 th edition, Pearson Education				
2.	V. D. Toro, Electrical Engineering Fundamentals, 2nd edition. PHI, 2014				
Reference Books					
1.	R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th edition. Pearson, 2012				
2.	DP Kothari & I J Nagrath, Basic Electric Engineering, 2019, 4 th edition, McGraw Hill Education				
Mode of Evaluation: CAT, Written Assignment, Quiz, FAT					
Recommended by Board of Studies				28.05.2022	
Approved by Academic Council		No. 67	Date	08.08.2022	

Course Code	Course Title	L	T	P	C
BEEE102P	Basic Electrical and Electronics Engineering Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Design and solve the fundamental electrical and electronics circuits					
Course Outcome					
At the end of the course, the student will be able to:					
1. Identify appropriate method of solving the fundamental electrical and electronics circuits					
2. Design and conduct experiments on electrical and electronics circuits					
Indicative Experiments					
1	Verification of Kirchoff's law				
2	Verification of Maximum Power Transfer Theorem				
3	Staircase wiring circuit layout for multi storage building				
4	Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars.				
5	Measurement of Earth resistance using Megger				
6	Sinusoidal steady state response of RLC circuits				
7	Three phase power measurement for ac loads				
8	Design of half-adder and full-adder digital circuits				
9	Synthesis of 8x1 multiplexer and 1x8 de-multiplexers				
10	Characteristics of PN diode and acts as switch				
11	Realization of single-phase rectifier				
12	Design of regulated power supply using Zener diode.				
13	Characteristics of MOSFET				
14	Characteristics of BJT				
15	Measurement of energy using single-phase energy meter				
16	Measurement of power in a 1-phase circuit by using CTs and PTs				
Total Laboratory Hours					30 hours
Text Book(s)					
1	Allan R. Hambley, Electrical Engineering: Principles & Applications, 2019, 7 th edition, Pearson Education				
Mode of assessment: CAT, FAT					
Recommended by Board of Studies			28-05-2022		
Approved by Academic Council			No. 67	Date	08.08.2022

Course Code	Course Title	L	T	P	C
BCSE101E	Computer Programming: Python	1	0	4	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To provide exposure to basic problem-solving techniques using computers. 2. To inculcate the art of logical thinking abilities and propose novel solutions for real world problems through programming language constructs.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Apply algorithmic thinking to solve real-world problems using Python. 2. Solve mathematical calculation using basic python statements.					
Module:1	Introduction to Problem Solving	1 hour			
Problem Solving: Definition and Steps, Problem Analysis Chart, Developing an Algorithm, Flowchart and Pseudocode.					
Module:2	Python Programming Fundamentals	2 hours			
Introduction to python – Interactive and Script Mode – Indentation – Comments – Variables – Reserved Words – Data Types – Operators and their precedence – Expressions – Built-in Functions – Importing from Packages.					
Module:3	Control Structures	2 hours			
Decision Making and Branching: if, if-else, nested if, multi-way if-elif statements – Looping: while loop, for loop – else clauses in loops, nested loops – break, continue and pass statements.					
Module:4	Collections	3 hours			
Lists: Create, Access, Slicing, Negative indices, List methods, List comprehensions – Tuples: Create, Indexing and slicing, Operations on tuples – Dictionary: Create, add, and replace values, Operations on dictionaries — Sets: Creation and operations.					
Module:5	Strings and Regular Expressions	2 hours			
Strings: Comparison, Formatting, Slicing, Splitting, Stripping – Regular Expressions: Matching, Search and replace, Patterns.					
Module:6	Functions and Files	3 hours			
Functions – Parameters and Arguments: Positional arguments, Keyword arguments, Parameters with default values – Local and Global scope of variables – Functions with Arbitrary arguments – Recursive Functions – Lambda Function. Files: Create, Open, Read, Write, Append and Close – tell and seek methods.					
Module:7	Modules and Packages	2 hours			
Built-in modules – User-Defined modules – Overview of Numpy and Pandas packages.					
		Total Lecture hours:		15 hours	
Text Book(s)					
1.	Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No starch Press, 2019				
Reference Books					
1.	Martie C Brown, Python: The Complete Reference, 4th Edition, McGraw Hill Publishers, 2018.				
2.	John V. Guttag, Introduction to computation and programming using python: with applications to understanding data. 2nd Edition, MIT Press, 2016.				
Mode of Evaluation: No separate evaluation for theory component.					
Indicative Experiments					
1.	Problem Analysis Chart, Flowchart and Pseudocode Practices.				
2.	Sequential Constructs using Python Operators, Expressions.				

3.	Branching (if, if-else, nested if, multi-way if-elif statements) and Looping (for, while, nested looping, break, continue, else in loops).		
4.	List, Tuples, Dictionaries & Sets.		
5.	Strings, Regular Expressions.		
6.	Functions, Lambda, Recursive Functions and Files.		
7.	Modules and Packages (NumPy and Pandas)		
Total Laboratory Hours			60 hours
Text Book(s)			
1.	Mariano Anaya, Clean Code in Python: Develop maintainable and efficient code, 2 nd Edition, Packt Publishing Limited, 2021.		
Reference Books			
1.	Harsh Bhasin, Python for beginners, 1 st Edition, New Age International (P) Ltd., 2019,		
Mode of assessment: Continuous assessments and FAT			
Recommended by Board of Studies		03.07.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

Course Code	Course Title	L	T	P	C
BCSE103E	Computer Programming: Java	1	0	4	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. To introduce the core language features of Java and understand the fundamentals of Object - Oriented programming in Java.					
2. To develop the ability of using Java to solve real world problems.					
Course Outcome:					
At the end of the course, the student will be able to:					
1. Apply the basics of programming constructs to solve real world problems.					
2. Develop java classes with object and references using constructors and destructors.					
Module:1	Java Basics	2 hours			
OOP Paradigm - Features of Java Language - JVM - Bytecode - Java program structure — Basic programming constructs - data types - variables – Java naming conventions – operators.					
Module:2	Looping Constructs and Arrays	2 hours			
Control and looping constructs - Arrays – one dimensional and multi-dimensional –enhanced for loop – Strings - Wrapper classes.					
Module:3	Classes and Objects	2 hours			
Class Fundamentals – Access and non-access specifiers - Declaring objects and assigning object reference variables – array of objects – constructors and destructors – usage of “this” and “static” keywords.					
Module:4	Inheritance and Polymorphism	3 hours			
Inheritance – types – use of “super” – final keyword - Polymorphism – Overloading and Overriding - abstract class – Interfaces.					
Module:5	Packages and Exception Handling	2 hours			
Packages: Creating and Accessing - Sub packages. Exception Handling - Types of Exception - Control Flow in Exceptions - Use of try, catch, finally, throw, throws in Exception Handling - User defined exceptions.					
Module:6	IO Streams and Files	2 hours			
Java I/O streams – File Input Stream & File Output Stream – File Reader & File Writer- Data Input Stream & Data Output Stream – Buffered Input Stream & Buffered Output Stream – Print Output Stream - Serialization and Deserialization.					
Module:7	Collection Framework	2 hours			
Generic classes and methods - Collection framework: List and Map.					
	Total Lecture hours:	15 hours			
Text Book(s)					
1.	Y. Daniel Liang, “Introduction to Java programming” - comprehensive version-11 th Edition, Pearson publisher, 2017.				
Reference Books					
1.	Herbert Schildt, The Complete Reference -Java, Tata McGraw-Hill publisher, 10 th Edition, 2017.				
2	Cay Horstmann,” Big Java”, 4th edition, John Wiley & Sons publisher, 5 th edition, 2015				
3	E. Balagurusamy, “Programming with Java”, Tata McGraw-Hill publishers, 6 th edition, 2019				
Mode of Evaluation: No separate evaluation for theory component.					
Indicative Experiments					
1.	Programs using sequential and branching structures.				

2.	Experiment the use of looping, arrays and strings.		
3.	Demonstrate basic Object-Oriented programming elements.		
4.	Experiment the use of inheritance, polymorphism and abstract classes.		
5.	Designing packages and demonstrate exception handling.		
6.	Demonstrate the use of IO streams, file handling and serialization.		
7.	Program to discover application of collections.		
Total Laboratory Hours		60 hours	
Text Book(s)			
1.	Marc Loy, Patrick Niemeyer and Daniel Leuck, Learning Java, O'Reilly Media, Inc., 5 th Edition, 2020.		
Reference Books			
1.	Dhruti Shah, 100+ Solutions in Java: A Hands-On Introduction to Programming in Java, BPB Publications, 1 st Edition, 2020.		
Mode of assessment: Continuous assessments and FAT			
Recommended by Board of Studies		03.07.2021	
Approved by Academic Council	No. 63	Date	23.09.2021

Course Code	Course Title	L	T	P	C
BENG101N	Effective English Communication	0	0	4	2
Pre-requisite	NIL	Syllabus Version			
		1.0			
Course Objectives:					
1. To hone LSRW skills for effective communication					
2. To enhance communication skills for future career aspirations					
3. To gain critical communication skills in writing and public speaking					
Course Outcomes:					
At the end of the course, the student will be able to:					
1. Write effective sentences using appropriate grammar and vocabulary					
2. Express clearly in everyday conversations with lucid pronunciation					
3. Interpret the given listening inputs to ensure efficient understanding.					
4. Organize diverse reading techniques on a wide range of text materials to examine it.					
Indicative Experiments					
1.	Fundamentals of Grammar: Parts of Speech, Articles, Tenses, Sentence Structure, Types of Sentences, Subject-Verb Agreement Activity: Exercises and worksheets				
2.	Speaking for Self-Expression: Formal Self-Introduction, Expressing Oneself Activity: Self-Introduction, Just a Minute (JAM)				
3.	Basic Listening: Listening to Simple Conversations, Short Speeches/Stories Activity: Gap fill exercises				
4.	Reading Skills: Reading Strategies, Skimming and Scanning Activity: Cloze reading, Reading comprehension, Reading newspaper articles				
5.	Drafting Paragraphs: Keywords Development, Writing Paragraphs using Connectives Activity: Picture and poster interpretation				
6.	Vocabulary Enrichment: Synonyms and Antonyms, Prefixes and Suffixes, Word Formation, One Word Substitution, Frequently used Idioms and Phrases, Homophones and Homonyms Activity: Crossword puzzles and worksheets				
7.	Listening for Pronunciation: Introduction to Phonemes, Listening to Native Speakers, Listening to Various Accents Activity: Listening and imitating, Spell Bee				
8.	Interactive Speaking: Everyday Conversations, Team Interactions, Simulations Activity: Situational role plays				
9.	Email and Letter Writing: Types and Format of Emails and Letters Activity: Official e-mails and letters, personal letters				
10.	Reading for Comprehension: Short Stories by Indian Writers Activity: Summarizing, loud reading				
Total Laboratory Hours					60 hours
Mode of Evaluation: Continuous assessment / FAT / Written assignments / Quiz/ Oral examination / Group activity					
Recommended by Board of Studies		28.06.2021			
Approved by Academic Council		No. 63	Date	23.09.2021	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Write effective sentences using appropriate grammar and vocabulary	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO2	Express clearly in everyday conversations with lucid pronunciation	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CO3	Interpret the given listening inputs to ensure efficient understanding.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CO4	Organize diverse reading techniques on a wide range of text materials to examine it.	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-

Course Code	Course Title	L	T	P	C
BENG101L	Technical English Communication	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. To develop LSRW skills for effective communication in professional situations 2. To enhance knowledge of grammar and vocabulary for meaningful communication 3. To understand information from diverse texts for effective technical communication					
Course Outcomes:					
At the end of the course, the student will be able to: 1. Utilize proper grammar and terminology while writing and speaking. 2. Apply the principles of effective communication in both official and casual situations. 3. Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences. 4. Prepare with clarity and significance in both academic and informal context.					
Module:1	Introduction to Communication	4 hours			
Nature and Process - Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal communication / Cross-cultural Communication - Communication Barriers and Essentials of good communication - Principles of Effective Communications					
Module:2	Grammatical Aspects	4 hours			
Sentence Pattern - Modal Verbs - Concord (SVA) - Conditionals - Error detection					
Module:3	Written Correspondence	4 hours			
Job Application Letters - Resume Writing - Statement of Purpose					
Module:4	Business Correspondence	4 hours			
Business Letters: Calling for Quotation, Complaint & Sales Letter – Memo - Minutes of Meeting - Describing products and processes					
Module:5	Professional Writing	4 hours			
Paraphrasing & Summarizing - Executive Summary - Structure and Types of Proposal – Recommendations					
Module:6	Team Building & Leadership Skills	4 hours			
Principles of Leadership - Team Leadership Model - Negotiation Skills - Conflict Management					
Module:7	Research Writing	4 hours			
Interpreting and analysing a research article - Approaches to Review Paper Writing - Structure of a research article – Referencing					
Module:8	Guest Lecture from Industry and R&D organizations	2 hours			
Contemporary Issues					
Total Lecture hours:					30 hours
Text Book(s)					
1.	Raman, Meenakshi & Sangeeta Sharma. (2015). <i>Technical Communication: Principles and Practice</i> , (3 rd Edition). India: Oxford University Press.				
Reference Books					
1.	Taylor, Shirley & Chandra.V. (2010). <i>Communication for Business A Practical Approach</i> 4 th Edition. India: Pearson Longman.				
2.	Kumar, Sanjay & Pushpalatha. (2018). <i>English Language and Communication Skills for Engineers</i> . India: Oxford University Press.				
3.	Koneru Aruna. (2020). <i>English Language Skills for Engineers</i> . India: McGraw Hill Education.				
4.	Rizvi, M. Ashraf. (2018). <i>Effective Technical Communication</i> 2 nd Edition. Chennai: McGraw Hill Education.				

5.	Mishra, Sunitha & Muralikrishna, C. (2014). <i>Communication Skills for Engineers</i> . India: Pearson Education.		
6.	Watkins, P. (2018). <i>Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers</i> . India: Cambridge University Press.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Group Discussion			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council	No. 63	Date	23.09.2021

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Utilize proper grammar and terminology while writing and speaking.	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO2	Apply the principles of effective communication in both official and casual situations.	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO3	Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CO4	Prepare with clarity and significance in both academic and informal context.	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-

Course Code	Course Title	L	T	P	C
BENG101P	Technical English Communication Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. To use appropriate grammatical structures in professional communication 2. To improve English communication skills for better employability 3. To enhance meaningful communication skills in writing and public speaking					
Course Outcomes:					
At the end of the course, the student will be able to: 1. Demonstrate professional rhetoric to articulate ideas and concepts effectively. 2. Elucidate the assigned readings and deliver eloquent presentations. 3. Apply receptive skills to improve communication at work and in everyday circumstances.					
Indicative Experiments					
1.	Grammar & Vocabulary Error Detection Activity: -Worksheets				
2.	Listening to Narratives Interviews of eminent personalities & Ted Talks Activity: Listening Comprehension / Summarising				
3.	Video Resume SWOT Analysis & digital resume techniques Activity: Preparing a digital résumé for mock interview				
4.	Product & Process Description Describing and Sequencing Activity: Demonstration of product and process				
5.	Mock Meetings Types of meetings and meeting etiquette Activity: Conduct of meetings and drafting minutes of the meeting				
6.	Reading research article Scientific and Technical articles Activity: Writing Literature review				
7.	Analytical Reading Case Studies on Communication, Team Building and Leadership Activity: Group Discussion				
8.	Presentations Preparing Conference/Seminar paper Activity: Individual/ Group presentations				
9.	Intensive Listening Scientific documentaries Activity: Note taking and Summarising				
10.	Interview Skills, Interview questions and techniques, Activity: Mock Interviews				
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment / FAT / Written Assignments / Quiz/ Oral Presentation and Group Activity.					
Recommended by Board of Studies			28.06.2021		
Approved by Academic Council			No. 63	Date	23.09.2021

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Demonstrate professional rhetoric to articulate ideas and concepts effectively.	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO2	Elucidate the assigned readings and deliver eloquent presentations.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CO3	Apply receptive skills to improve communication at work and in everyday circumstances.	-	-	-	-	-	-	-	-	3	-	-	3	-	-	-

Course Code	Course Title	L	T	P	C
BENG201P	Technical Report Writing	0	0	2	1
Pre-requisite	Technical English Communication	Syllabus version			
		1.0			
Course Objectives:					
1. To augment specific writing skills for preparing technical reports					
2. To think critically, evaluate, analyse general and complex technical information					
3. To acquire proficiency in writing and presenting reports					
Course Outcomes:					
At the end of the course, the student will be able to:					
1. Write error free sentences using appropriate grammar, vocabulary and style					
2. Synthesize information and concepts in preparing reports					
3. Demonstrate the ability to write and present reports on diverse topics					
Indicative Experiments					
1.	Advanced Grammar, Vocabulary and Editing Usage of Tenses - Adjectives and Adverbs - Jargon vs Technical Vocabulary — Abbreviations - Mechanics of Editing: Punctuation and Proof Reading Activity: Worksheets				
2.	Research and Analyses Synchronies Technical Details from Newspapers - Magazines - Articles and e-content Activity: Writing introduction and literature review				
3.	Systematization of Information Techniques to Converge Objective-Oriented data in Diverse Technical Reports Activity: Preparing Questionnaire				
4.	Data Visualisation Interpreting Data - Graphs - Tables — Charts - Imagery - Infographics Activity: Transcoding				
5.	Introduction to Reports Meaning - Definition - Purpose - Characteristics and Types of Reports Activity: Worksheets on Types of reports				
6.	Structure of Reports Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations Activity: Identifying the structure of report				
7.	Report Writing Data Collection - Draft an Outline and Organize Information Activity: Drafting reports				
8.	Supplementary Texts Appendix – Index – Glossary – References – Bibliography - Notes Activity: Organizing supplementary texts				
9.	Review of Final Reports Structure – Content – Style - Layout and Referencing Activity: Examining clarity and coherence in final reports				
10.	Presentation Presenting Technical Reports Activity: Planning, creating and digital presentation of reports				
Total Laboratory Hours					30 hours
Mode of assessment: Continuous Assessment / FAT / Assignments / Quiz / Presentations / Oral examination					

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Write error free sentences using appropriate grammar, vocabulary and style	-	-	-	-	-	-	-	-	3	-	-	2	-	-	-
CO2	Synthesize information and concepts in preparing reports	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO3	Demonstrate the ability to write and present reports on diverse topics	-	-	-	-	-	-	-	-	3	-	-	2	-	-	-

Course Code	Course Title	L	T	P	C
BSTS101P	Quantitative Skills Practice I	0	0	3	1.5
Pre-requisite	NIL	Syllabus Version			
		1.0			
Course Objectives:					
1. To enhance the logical reasoning skills of the students and help them improve problem-solving abilities 2. To acquire skills required to solve quantitative aptitude problems 3. To boost the verbal ability of the students for academic and professional purposes					
Course Outcomes:					
At the end of the course, the student will be able to: 1. Apply quantitative aptitude concepts and methods to solve problems in academic and placement assessments. 2. Analyse logical reasoning problems to identify relationships and determine appropriate solutions. 3. Apply verbal ability strategies to interpret and solve questions in academic and placement contexts.					
MModule:1	Logical Reasoning	5 hours			
Word group categorization questions Puzzle type class involving students grouping words into right group orders of logical sense Cryptarithmic					
Module:2	Data arrangements and Blood relations	6 hours			
Linear Arrangement - Circular Arrangement - Multi-dimensional Arrangement - Blood Relations					
Module:3	Ratio and Proportion	6 hours			
Ratio Proportion - Variation Simple equations Problems on Ages - Mixtures and allegations.					
Module:4	Percentages, Simple and Compound Interest	6 hours			
Percentages as Fractions and Decimals - Percentage Increase / Decrease - Simple Interest -Compound Interest - Relation Between Simple and Compound Interest					
Module:5	Number System	6 hours			
Number system- Power cycle - Remainder cycle - Factors, Multiples - HCF and LCM					
Module:6	Essential grammar for Placement	7 hours			
• Prepositions • Adjectives and Adverbs • Tense • Speech and Voice • Idioms and Phrasal Verbs • Collocations, Gerunds and Infinitives • Definite and Indefinite Articles • Omission of Articles • Prepositions • Compound Prepositions and Prepositional Phrases • Interrogatives					
Module:7	Reading Comprehension for Placement	3 hours			
Types of questions - Comprehension strategies - Practice exercises					
Module:8	Vocabulary for Placement	6 hours			
Exposure to questions related to Synonyms- Antonyms - Analogy -					

Confusing words - Spelling correctness			
	Total Lecture hours :	45 hours	
Text Book (s)			
1.	SMART. (2018). Place Mentor 1st (Ed.). Chennai: Oxford University Press.		
2.	Aggarwal R.S. (2017). Quantitative Aptitude for Competitive Examinations 3rd (Ed.). New Delhi: S. Chand Publishing.		
3.	FACE. (2016). Aptipedia Aptitude Encyclopedia 1st (Ed.). New Delhi: Wiley Publications.		
4.	ETHNUS. (2016). Aptimithra, 1st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.		
Reference Books			
1.	Sharma Arun. (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.		
Mode of Evaluation: CAT, Assessments and FAT (Computer Based Test)			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council	No. 63	Date	23.09.2021

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Apply quantitative aptitude concepts and methods to solve problems in academic and placement assessments.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	Analyse logical reasoning problems to identify relationships and determine appropriate solutions.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	Apply verbal ability strategies to interpret and solve questions in academic and placement contexts.	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

Course Code	Course Title	L	T	P	C
BSTS102P	Quantitative Skills Practice II	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. Help to trigger the students' logical thinking skills and apply it in real-life scenarios					
2. Learn to deploy the strategies of solving quantitative ability problems					
3. To expand the verbal ability of students					
4. Assist to run the gamut of employability skills					
Course Outcomes:					
At the end of the course, the student will be able to:					
1. Apply logical reasoning and data interpretation to solve advanced problems.					
2. Solve advanced quantitative aptitude problems using systematic methods.					
3. Demonstrate written and oral communication proficiency in competitive assessments.					
Module:1	Logical Reasoning puzzles - Advanced	2 hours			
Advanced puzzles:					
• Sudoku					
• Mind-bender style word statement puzzles					
• Anagrams					
• Rebus puzzles					
Module:2	Logical connectives, Syllogism and Venn diagrams	2 hours			
Logical Connectives - Advanced Syllogisms - 4, 5, 6 and other multiple statement problems					
- Challenging Venn Diagram questions: Set theory					
Module:3	Permutation, Combination and Probability - Advanced	4 hours			
Fundamental Counting Principle- Permutation and Combination - Computation of Permutation -					
Advanced problems - Circular Permutations - Computation of Combination - Advanced problems -					
Advanced probability					
Module:4	Quantitative Aptitude	6 hours			
Logarithms, Progressions, Geometry and Quadratic equations - Advanced					
• Logarithm					
• Arithmetic Progression					
• Geometric Progression					
• Geometry					
• Mensuration					
• Coded inequalities					
• Quadratic Equations					
Concepts followed by advanced questions of CAT level					
Module:5	Image interpretation	2 hours			
Image interpretation: Methods - Exposure to image interpretation questions through brainstorming and practice					
Module:6	Critical Reasoning - Advanced	3 hours			
Concepts of Critical Reasoning - Exposure to advanced questions of GMAT level					
Module:7	Recruitment Essentials	8 hours			
Mock interviews					
Cracking other kinds of interviews					
Skype/ Telephonic interviews					
Panel interviews					
Stress interviews					

Guesstimation			
1. Best methods to approach Guesstimation questions			
2. Practice with impromptu interview on Guesstimation questions			
Case studies/ situational interview			
1. Scientific strategies to answer case study and situational interview questions			
2. Best ways to present cases			
3. Practice on presenting cases and answering situational interviews asked in recruitment rounds			
Module:8	Problem solving and Algorithmic skills		18 hours
Logical methods to solve problem statements in Programming - Basic algorithms introduced			
Total Lecture hours :			45 hours
Text Book (s)			
1.	SMART. (2018). Place Mentor 1st (Ed.). Chennai: Oxford University Press		
2.	Aggarwal R.S. (2017). Quantitative Aptitude for Competitive Examinations 3rd (Ed.). New Delhi: S. Chand Publishing.		
3.	FACE. (2016). Aptipedia Aptitude Encyclopedia 1st (Ed.). New Delhi: Wiley Publications.		
4.	ETHNUS. (2016). Aptimithra, 1st (Ed.) Bangalore: McGraw-Hill Education Pvt.Ltd.		
Reference Books			
1.	Sharma Arun. (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.		
Mode of Evaluation: CAT, Assessments and FAT (Computer Based Test)			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council	No. 63	Date	Date 23.09.2021

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Apply logical reasoning and data interpretation to solve advanced problems.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	Solve advanced quantitative aptitude problems using systematic methods.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	Demonstrate written and oral communication proficiency in competitive assessments.	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

Course code	Course Title	L	T	P	C
BSTS201P	Qualitative Skills Practice - I	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. To enhance the logical reasoning skills of students and improve problem-solving abilities 2. To strengthen the ability of solving quantitative aptitude problems 3. To enrich the verbal ability of the students for academic purposes					
Course Outcomes:					
At the end of the course, the student will be able to: 1. Apply quantitative aptitude methods to solve problems accurately and efficiently. 2. Analyse and evaluate logical reasoning concepts to assess alternative solutions and defend conclusions. 3. Demonstrate verbal ability skills effectively in academic and professional contexts.					
Module 1 :	Lessons on excellence	2 hours			
Skill introspection - Skill acquisition - consistent practice					
Module 2 :	Thinking Skill	6 hours			
• Problem Solving • Critical Thinking • Lateral Thinking • Rebus puzzles, and word-link builder questions					
Module 3 :	Logical Reasoning	6 hours			
• Coding and Decoding • Series • Analogy • Odd Man Out • Visual Reasoning					
Module 4:	Sudoku puzzles	3 hours			
Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers					
Module 5:	Attention to detail	3 hours			
Picture and word driven Qs to develop attention to detail as a skill					
Module 6:	Quantitative Aptitude	14 hours			
Speed Math's: • Addition and Subtraction of bigger numbers • Square and square roots • Cubes and cube roots • Vedic math's techniques Multiplication Shortcuts: • Multiplication of 3 and higher digit numbers • Simplifications • Comparing fractions • Shortcuts to find HCF and LCM • Divisibility tests shortcuts Algebra and functions					
Module: 7	Verbal Ability	6 hours			

Grammar challenge A practice paper with sentence based and passage-based questions on grammar discussed - Nouns and Pronouns, Verbs, Subject-Verb Agreement, Pronoun-Antecedent Agreement, Punctuations			
Verbal reasoning			
Module 8:	Recruitment Essentials	5 hours	
Looking at an engineering career through the prism of an effective resume • Importance of a resume - the footprint of a person's career achievements • Designing an effective resume • An effective resume vs. a poor resume • Skills you must build starting today - what is requisite? • How does one build skills? Impression Management • Getting it right for the interview: Grooming, dressing • Body Language and other non-verbal signs • Displaying the right Behaviour			
		Total Lecture hours :	45 hours
Text Book (s)			
1.	SMART. (2018). Place Mentor 1st (Ed.). Chennai: Oxford University Press.		
2.	Aggarwal R.S. (2017). Quantitative Aptitude for Competitive Examinations 3rd (Ed.). New Delhi: S. Chand Publishing.		
3.	FACE. (2016). Aptipedia Aptitude Encyclopedia 1st (Ed.). New Delhi: Wiley Publications.		
4.	ETHNUS. (2016). Aptimithra, 1st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.		
Reference Books			
1.	Sharma Arun. (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.		
Mode of Evaluation: CAT, Assessments and FAT (Computer Based Test)			
Recommended by Board of Studies		28-06-2021	
Approved by Academic Council		No. 68	Date 19-12-2022

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Apply quantitative aptitude methods to solve problems accurately and efficiently.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	Analyse and evaluate logical reasoning concepts to assess alternative solutions and defend conclusions.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	Demonstrate verbal ability skills effectively in academic and professional contexts.	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-

Course Code	Course Title	L	T	P	C
BSTS202P	Qualitative Skills Practice - II	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. To apply critical thinking skills related to their subject matter 2. To demonstrate competency in verbal, quantitative and reasoning aptitude 3. To produce good written skills for effective communication					
Course Outcomes:					
At the end of the course, the student will be able to:					
1. Solve logical reasoning problems in aptitude assessments. 2. Apply advanced counting principles in quantitative and competitive assessments. 3. Use verbal ability and quantitative aptitude skills in placement assessments.					
Module 1:	Logical Reasoning	5 hours			
Clocks Calendars Direction Sense Cubes Practice on advanced problems					
Module 2:	Data interpretation and Data sufficiency - Advanced	5 hours			
Advanced Data Interpretation and Data Sufficiency questions of CAT level Multiple chart problems Caselet problems					
Module 3:	Time and work- Advanced	5 hours			
Work with different efficiencies Pipes and cisterns: Multiple pipe problems Work equivalence Division of wages Advanced application problems with complexity in calculating total work					
Module 4:	Time, Speed and Distance - Advanced	5 hours			
Relative speed Advanced Problems based on trains Advanced Problems based on boats and streams Advanced Problems based on races					
Module 5:	Profit and loss, Partnerships and averages - Advanced	5 hours			
Partnership Averages Weighted average Advanced problems discussed					
Module 6:	Number system - Advanced	4 hours			
Advanced application problems on Numbers involving HCF, LCM, divisibility tests, and remainder and power cycles.					
Module 7:	Verbal Ability	13 hours			

Sentence Correction - Advanced

- Subject-Verb Agreement
- Modifiers
- Parallelism
- Pronoun-Antecedent Agreement
- Verb Time Sequences
- Comparisons
- Prepositions
- Determiners

Quick introduction to 8 types of errors followed by exposure to GMAT level questions

Sentence Completion and Para-jumbles - Advanced

- Pro-active thinking
- Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues)
- Fixed jumbles
- Anchored jumbles

Practice on advanced GRE/GMAT level questions

Reading Comprehension - Advanced

Exposure to RCs of the level of GRE/GMAT relating to a wide variety of subjects

Module 8:	Writing skills for Placement	3 hours
Essay writing • Idea generation for topics • Best practices • Practice and feedback		
	Total Lecture hours	45 hours
Text Book (s)		
1.	SMART. (2018). Place Mentor 1st (Ed.). Chennai: Oxford University Press.	
2.	Aggarwal R.S. (2017). Quantitative Aptitude for Competitive Examinations 3rd (Ed.). New Delhi: S. Chand Publishing.	
3.	FACE. (2016). Aptipedia Aptitude Encyclopedia 1st (Ed.). New Delhi: Wiley Publications.	
4.	ETHNUS. (2016). Aptimithra, 1st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.	
Reference Books		
1.	Sharma Arun. (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.	
Mode of Evaluation: CAT, Assessments and FAT (Computer Based Test)		
Recommended by Board of Studies		28-06-2021
Approved by Academic Council	No. 68	Date 19-12-2022

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Solve logical reasoning problems in aptitude assessments.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	Apply advanced counting principles in quantitative and competitive assessments.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	Use verbal ability and quantitative aptitude skills in placement assessments.	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

Course Code	Course Title	L	T	P	C
BECE201L	Electronic Materials and Devices	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1 To introduce the students with concepts of electronic materials and their properties 2 To demystify semiconductor device physics and electronics. 3 To equip the students with the tools for solving problems of semiconductor devices and circuits. 4 To familiarize the students with various electronic devices and their circuit applications.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Apply the basic principles of electrical and thermal conduction in solids. 2. Illustrate energy band diagrams of semiconductors. 3. Determine the carrier transport parameters of semiconductor devices. 4. Employ junction diodes in rectification and voltage-regulation applications 5. Compute the DC operating parameters of BJT circuits in different configurations. 6. Illustrate FET characteristics and its parameters.					
Module:1	Electrical and Thermal conduction in Solids	6 hours			
Crystalline state — Crystalline defects — Single Crystal Growth - Czochralski Growth — Amorphous Semiconductor - Classical Theory: Drude Model – Temperature dependence of resistivity – The Hall Effect and Hall Devices – Thermal conduction – Electrical conductivity of non-metals – Skin Effect – Thin metal films.					
Module:2	Semiconductor Fundamentals	7 hours			
Introduction to Solids, Crystals, and Electronic materials — Formation of energy bands — Energy band Model — Effective mass - Direct and indirect bandgap — Elemental and compound semiconductors, Intrinsic and extrinsic semiconductors. The density of states, Carrier statistics, Fermi level, Equilibrium carrier concentration, Quasi-equilibrium, and Quasi-Fermi level.					
Module:3	Carrier Transport Mechanism	6 hours			
Charge carriers in semiconductors – Drift and Diffusion of carriers – Mobility – Generation, Recombination and injection of carriers – Carrier transport equations – Excess carrier lifetime.					
Module:4	Junction diodes	8 hours			
PN Junction — Equilibrium and biased — Contact potential and space charge phenomena, Current – Voltage relationship, Diode capacitances, One-sided PN junction, Avalanche and Zener breakdown, Zener diode, small-signal model of PN junction. Metal-Semiconductor Contact: Schottky diode, current-voltage characteristics, Ohmic contacts. Varactor diode, Tunnel diode, Photo Diode, Solar Cells.					
Module:5	Bipolar Junction Transistor	5 hours			
Device structure and physical operation, Current – Voltage relationship – CB, CE, and CC configuration – Nonideal effects – Base width modulation – Ebers-Moll model. Small signal models, Device capacitances – Equivalent circuit model.					
Module:6	Field Effect Transistor	7 hours			
JFET, MOS Capacitors: Energy-band diagrams, flat-band, accumulation, depletion, inversion, threshold voltage, Capacitance-Voltage characteristics. MOSFETs: Current- Voltage characteristics, velocity saturation, leakage currents, short channel effects – V_t roll-off and drain-induced barrier lowering, scaling limits, alternative technologies. Equivalent circuit model-second order effects.					

Course Code	Course Title	L	T	P	C
BECE202L	Signals and Systems	2	1	0	3
Pre-requisite	BMAT102L	Syllabus version			
		1.0			
Course Objectives					
1. To understand the basic attributes of signals and systems. 2. To analyse the signals and systems in time and transformed domains such as Fourier, Laplace and Z- transform. 3. To understand the concept of sampling process.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Determine the properties of continuous and discrete-time signals 2. Determine the properties of continuous and discrete time systems. 3. Compute the spectral characteristics of continuous and discrete time signals using Fourier series. 4. Apply Fourier transform to characterize the continuous and discrete time signals and systems. 5. Apply Hilbert transform to represent the bandpass signals. 6. Solve differential and difference equations using Laplace and Z transforms.					
Module:1	Continuous Time and Discrete Time signals	7 hours			
Signal classification – Types of signals: Unit impulse, unit step, ramp, sign, and exponential signals – Operations on signals – Analogy between vectors and signals –Concept of linearly dependent and independent vectors, Orthogonality – Mean square error – Computation of energy, power, periodicity, Norms and moments of signals, – Distance metrics for signals.					
Module:2	Continuous Time and Discrete Time systems	7 hours			
Classification of systems — Linearity, time invariance, stability, Invertibility, Causality and memory systems. Interconnection of systems. Systems defined by differential & difference equations- Impulse and step response of the systems. Transmission of signals through LTI systems - Convolution and Correlation for CT and DT systems					
Module:3	Fourier Series	5 hours			
The response of LTI systems to complex exponentials, Fourier series representation of Continuous Time Periodic Signals, Gibb’s phenomena, Properties of CTFS, Fourier series representation of Discrete Time Periodic Signals, Properties of DTFS, Power spectral density.					
Module:4	Fourier Transforms	6 hours			
Representation of aperiodic continuous signals: The Continuous Time Fourier Transform, The Fourier Transform for Periodic Signals, Properties of CTFT, Systems characterized by linear constant-coefficient Differential Equations. Representation of aperiodic discrete signals: The Discrete Time Fourier Transform, The Fourier Transform for Periodic Signals, Properties of DTFT, DTFT of systems characterized by linear constant-coefficient Difference Equations. Energy spectral density.					
Module:5	Hilbert Transform and processing of Band Pass Signals	6 hours			
Magnitude and phase response of the systems, Group delay, Representation of bandpass signals: In-phase and quadrature phase components, Hilbert transform — Pre and complex envelopes. Processing of bandpass signals through bandpass systems.					
Module:6	Sampling	4 hours			
Impulse train sampling -Zero order hold, Nyquist criteria – Aliasing - Reconstruction – Ideal filtering					
Module:7	Laplace and Z-Transform	8 hours			
Laplace transform: Definition – ROC – Properties – S-plane causality and BIBO stability – Transfer function – Unilateral Laplace transform: Solution of differential equations with initial conditions.					

Course Code	Course Title	L	T	P	C
BECE203L	Circuit Theory	3	1	0	4
Pre-requisite	BEEE101L, BEEE101P	Syllabus version			
		1.0			
Course Objectives					

Course Code	Course Title	L	T	P	C
BECE102L	Digital Systems Design	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Provide an understanding of Boolean algebra and logic functions. 2. Develop the knowledge of combinational and sequential logic circuit design. 3. Design and model the data path circuits for digital systems. 4. Establish a strong understanding of programmable logic. 5. Enable the student to design and model the logic circuits using Verilog HDL.					
Course Outcome					
At the end of the course, the student will be able to: 1. Apply Boolean principles and K-map to optimize the logic functions 2. Illustrate different modelling styles of Verilog HDL 3. Construct various combinational logical circuit and modelling using Verilog HDL. 4. Build various sequential logic circuits and modelling using Verilog HDL. 5. Implement Finite State machines using Moore and Mealy models. 6. Illustrate programmable logic devices and FPGA architectures.					
Module:1	Digital Logic	8 hours			
Boolean Algebra: Basic definitions, Axiomatic definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Simplification of Boolean functions. Gate-Level Minimization: The Map Method (K-map up to 4 variable), Product of Sums and Sum of Products Simplification, NAND and NOR Implementation. Logic Families: Digital Logic Gates, TTL and CMOS logic families.					
Module:2	Verilog HDL	5 hours			
Lexical Conventions, Ports and Modules, Operators, Dataflow Modelling, Gate Level Modelling, Behavioural Modeling, Test Bench.					
Module:3	Design of Combinational Logic Circuits	8 hours			
Design Procedure, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Decoders, Encoders, Multiplexers, De-multiplexers, Parity generator and checker, Applications of Decoder, Multiplexer and De-multiplexer. Modeling of Combinational logic circuits using Verilog HDL.					
Module:4	Design of data path circuits	6 hours			
N-bit Parallel Adder/Subtractor, Carry Look Ahead Adder, Unsigned Array Multiplier, Booth Multiplier, 4-Bit Magnitude comparator. Modeling of data path circuits using Verilog HDL.					
Module:5	Design of Sequential Logic Circuits	8 hours			
Latches, Flip-Flops - SR, D, JK & T, Buffer Registers, Shift Registers - SISO, SIPO, PISO, PIPO, Design of synchronous sequential circuits: state table and state diagrams, Design of counters: Modulo-n, Johnson, Ring, Up/Down, Asynchronous counter. Modeling of sequential logic circuits using Verilog HDL.					
Module:6	Design of FSM	4 hours			
Finite state Machine (FSM): Mealy FSM and Moore FSM, Design Example: Sequence detection, Modeling of FSM using Verilog HDL.					
Module:7	Programmable Logic Devices	4 hours			
Types of Programmable Logic Devices: PLA, PAL, CPLD, FPGA Generic Architecture.					
Module:8	Contemporary issues	2 hours			
Total Lecture hours:					45 hours
Textbook(s)					

Course Code	Course Title	L	T	P	C
BECE102P	Digital Systems Design Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objective					
To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Implement combinational, sequential and data path circuits using Verilog HDL and verify their functional behaviour. 2. Apply finite state machine (FSM) concepts using Verilog HDL for FPGA-based applications 3. Employ Verilog HDL techniques to realize optimized digital architectures on FPGA.					
Indicative Experiments					
1.	Characteristics of Digital ICs, Realization of Boolean expressions				2 hours
2.	Design and Verilog modeling of Combinational Logic circuits				4 hours
3.	Design and Verilog modeling of various data path elements - Adders				2 hours
4.	Design and Verilog modeling of various data path elements - Multipliers				2 hours
5.	Implementation of combinational circuits – (FPGA / Trainer Kit)				2 hours
6.	Implementation of data path circuit - (FPGA / Trainer Kit)				2 hours
7.	Design and Verilog modeling of simple sequential circuits like Counters and Shift registers				2 hours
8.	Design and Verilog modeling of complex sequential circuits				2 hours
9.	Implementation of Sequential circuits - (FPGA / Trainer Kit)				2 hours
10.	Design and Verilog modeling of FSM based design – Serial Adder				2 hours
11.	Design and Verilog modeling of FSM based design – Traffic Light Controller / Vending Machine				4 hours
12.	Design of ALU				4 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Implement combinational, sequential and data path circuits using Verilog HDL and verify their functional behaviour.	3	-	-	-	3	-	-	-	2	2	-	2	3	-	-
CO2	Apply finite state machine (FSM) concepts using Verilog HDL for FPGA-based applications	3	-	-	-	3	-	-	-	2	2	-	2	3	-	-
CO3	Employ Verilog HDL techniques to realize optimized digital architectures on FPGA.	3	-	-	-	3	-	-	-	2	2	-	2	3	-	-

Course Code	Course Title	L	T	P	C
BECE204L	Microprocessors and Microcontrollers	3	0	0	3
Pre-requisite	BECE102L	Syllabus version			
		1.0			
Course Objectives:					
<					

Course Code	Course Title	L	T	P	C
BECE204P	Microprocessors and Microcontrollers Lab	0	0	2	1
Pre-requisite	BECE102L	Syllabus version			
		1.0			
Course Objectives					
1. To familiarize the students with assembly language programming using microprocessor and microcontroller.					
2. To familiarize the students with Embedded C language programming using microcontroller.					
3. To interface peripherals and I/O devices with the microcontroller and microprocessor.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Implement assembly language programs for the 8086 microprocessor and 8051 microcontrollers.					
2. Perform peripheral Interfacing for 8051 microcontrollers for real-time applications.					
Indicative Experiments [Experiments using 8086/8051/ARM]					
1	Assembly language programming of Arithmetic/logical operations.				6 hours
2	Assembly language programming of memory operations.				4 hours
3	Assembly language programming/ Embedded C programming for interfacing the peripherals: General purpose input/ output, timers, serial communication, LCD, keypad and ADC.				10 hours
4	Hardware implementation of peripheral interfacing: General purpose input/ output, timers, serial communication, LCD, keypad and ADC.				10 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies			14-05-2022		
Approved by Academic Council			No. 66	Date	16-06-2022

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Implement assembly language programs for the 8086 microprocessor and 8051 microcontrollers.	3	-	-	-	3	-	-	-	2	2	-	2	-	-	3
CO2	Perform peripheral Interfacing for 8051 microcontrollers for real-time applications	3	-	-	-	3	-	-	-	2	2	-	2	-	-	3

Course Code	Course Title	L	T	P	C
BECE205L	Engineering Electromagnetics	3	0	0	3
Pre-requisite	BPHY101L, BPHY101P	Syllabus version			
		1.0			
Course Objectives					
1. Introduce the basic concepts and properties of Electrostatics & Magnetostatics. 2. Study the propagation of EM wave through time varying Maxwell’s equations and to analyze the EM Wave propagation in different conducting and dielectric media. 3. Familiarize the concept of transmission and reflection in various transmission lines and to design different transmission lines and matching circuits using Smith chart.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Compute divergence, gradient, and curl in different coordinate systems. 2. Determine the electric and magnetic fields of a medium using electromagnetic principles. 3. Solve Time -varying electromagnetic Fields using Maxwell’s equations. 4. Compute transmission line parameters for lossless, lossy and distortion less conditions 5. Illustrate impedance matching circuits using Smith chart. 6. Solve electric and magnetic field components in waveguides					
Module:1	Vector Calculus	3 hours			
Cartesian, Cylindrical, and Spherical coordinate systems. Divergence, Gradient and Curl.					
Module:2	Electrostatics	8 hours			
Coulomb’s Law, Electric Fields due to Different Charge Distributions, Gauss Law and Applications, Electrostatic Potential, Potential Gradient, Equipotential surfaces, Electric Dipole, Polarization in Dielectrics, Boundary conditions, current density, continuity equation. Laplace and Poisson’s equation, Capacitance, Method of Images.					
Module:3	Magnetostatics	7 hours			
Biot-Savart’s Law, Ampere’s Circuit Law and Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Magnetic Dipole, Magnetization in materials, Boundary conditions, Inductances and Magnetic Energy.					
Module:4	Time Varying Fields	5 hours			
Faraday’s Law and Lenz law, Maxwell’s Equations in Integral and differential form, Wave equation, Uniform plane wave propagation in lossy dielectrics, Lossless Dielectrics, Good conductors and free space. Polarization, Power and Poynting Vector.					
Module:5	Transmission Lines	8 hours			
Types, Parameters, Transmission Line Equations, Primary & Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase velocity, _input impedance, Reflection Coefficient, VSWR. Characterization of lossless, low loss and distortion less transmission lines. Significance of short circuit and open circuit lines of length $\lambda/8$, $\lambda/4$ and $\lambda/2$. Coaxial line, Planar transmission lines –Types, Microstrip Lines: field distribution, design equations, Q factor, losses in microstrip lines.					
Module:6	Smith Chart & Matching Circuits	7 hours			
Smith Chart configuration and applications: Input impedance, admittance, VSWR, Reflection Coefficient, return loss, standing wave pattern. Matching Circuit Design- Quarter wave, Impedance Transformer, Single Stub, Double Stub and Lumped element matching.					
Module:7	Waveguides	5 hours			
TEM, TE and TM waves, Parallel plate waveguide, rectangular waveguide, Characteristics of wave guide- guide wavelength, cut off wave length, cut off frequency, wave impedance, phase constant, phase velocity, group velocity. Circular waveguide and Cavity resonator (Qualitative study)					

Course Code	Course Title	L	T	P	C
BECE206L	Analog Circuits	3	0	0	3
Pre-requisite	BECE201L	Syllabus version			
		1.0			
Course Objectives					
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Course Code	Course Title	L	T	P	C
BECE206P	Analog Circuits Lab	0	0	2	1
Pre-requisite	BECE201L	Syllabus version			
		1.0			
Course Objective					
To apply knowledge gained in the theory course and get hands-on experience of the topics.					
Course Outcome					
At the end of the course, the student will be able to:					
1. Simulate the frequency response of amplifier circuits 2. Compute the power conversion efficiency for different classes of power amplifiers. 3. Use Integrated Circuits for waveform generation and signal conditioning.					
Indicative Experiments					
1.	Design of single-stage and multistage amplifiers using BJT and to analyse its frequency response characteristics.	4 hours			
2.	Design of single-stage and multistage amplifiers using MOSFET and to analyse its frequency response characteristics.	4 hours			
3.	Design of a Power Amplifier and estimation of its power conversion efficiency	2 hours			
4.	Design of differential amplifier using MOSFET and determine its CMRR and also perform the frequency response analysis.	4 hours			
5.	Design of closed-loop amplifiers using Op-amp and perform experimentation to determine voltage gain.	2 hours			
6.	Design of circuits using op-amp to determine the DC and AC characteristics.	4 hours			
7.	Design of Instrumentation amplifier for the given specifications.	2 hours			
8.	Design of Comparator and Schmitt trigger circuits using Op-amp.	4 hours			
9.	Design of waveform generators and filters using op-amp	2 hours			
10.	Design of circuits using IC 555 timer for different applications.	2 hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Simulate the frequency response of amplifier circuits	3	-	-	-	3	-	-	-	2	2	-	-	3	-	-
CO2	Compute the power conversion efficiency for different classes of power amplifiers.	3	-	-	-	3	-	-	-	2	2	-	-	3	-	-
CO3	Use Integrated Circuits for waveform generation and signal conditioning.	3	-	-	-	-	-	-	-	2	2	-	2	3	-	-

Course Code	Course Title	L	T	P	C
BECE207L	Random Processes	2	1	0	3
Pre-requisite	BMAT202L, BMAT202P, BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To familiarize the students with two and multi-random variable theory. 2. To enable the students process the random signals in time and frequency domains. 3. To make the students understand the noise concepts and design a matched filter to increase the Signal to Noise Ratio (SNR).					
Course Outcome					
At the end of the course, the student will be able to: 1. Compute the moments using probability density functions of multiple random variables 2. Compute the probability density functions of multiple random variables using transformation techniques. 3. Determine the temporal characteristics of random processes. 4. Compute power spectral density of the random signals 5. Apply LTI system principles to systems with random input signals. 6. Implement optimum linear systems for extracting signals in the presence of noise.					
Module:1	Continuous and Discrete Multiple Random Variables	6 hours			
Introduction to Random Variables – Vector Random Variables- Joint Distribution and its Properties- Joint Density and its Properties-Joint Probability Mass Function – Conditional Distribution and Density- Statistical Independence –Distribution and Density of Function of Random Variables – Central Limit Theorem.					
Module:2	Operations on Multiple Random Variables	7 hours			
Joint Moments for continuous and discrete random variables – Joint Central Moments – Joint Characteristics Function – Jointly Gaussian Random Variables – Transformations of Multiple Random Variables – Linear Transformation of Gaussian Random Variables – Complex Random Variables.					
Module:3	Random Processes – Temporal Characteristics	7 hours			
Random Process: Classifications. Stationarity and Independence. Time Averages and Ergodic Random process. Characterizing a Random Process: The Mean, Correlation Functions, Covariance Functions, and their Properties-Different processes: Gaussian Random Process- Poisson Random Process, Weiner Process, and Markov process, and Complex Random Process.					
Module:4	Random Processes – Spectral Characteristics	7 hours			
Power Density Spectrum and its Properties-Cross PSD and its properties, Relationship between Correlation and Power Spectrum- Power Spectral density of a WSS discrete Time random processes and Sequences. Power Spectrum of Complex Processes.					
Module:5	Linear Systems with Random Inputs	5 hours			
Linear system Fundamentals-Linear systems with continuous-Time and discrete-Time random inputs. Random Signal Response of Linear Systems-Product Device response to a Random Signal-Spectral Characteristic of System Response. Response of quadratic, half wave, full-wave, and sigmoid detectors to Gaussian signals.					
Module:6	Noise and Modelling of Noise Sources	6 hours			
Noise Definitions- White noise and colored noise. System Evaluation using Random noise - Spectral Characteristic of System Response for Noise-Noise Bandwidth – Bandpass – Band limited – Narrow Band Processes. Resistive Noise Sources – Arbitrary Noise Sources – Effective Noise Sources-Noise Temperature-Noise Figure-Incremental Modelling of Noisy Networks- Modelling of Practical Noisy Networks.					
Module:7	Optimum Linear Systems	5 hours			

Course Code	Course Title	L	T	P	C
BECE301L	Digital Signal Processing	3	0	0	3
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To summarize and analyze the concepts of signals, systems in time and frequency domain with the corresponding transformations. 2. To inculcate the design concepts of analog, digital IIR, FIR filters. 3. To instill diverse structures for realizing digital filters. 4. To infuse the novice concepts of multirate digital signal processing.					
Course Outcome					
At the end of the course, the student will be able to 1. Determine the properties of discrete-time signals and systems in time and frequency domain. 2. Apply discrete Fourier transform for practical applications. 3. Illustrate the characteristics and properties of analog filter. 4. Analyze FIR and IIR digital filters for signal processing applications. 5. Illustrate the various realization structures for digital filters. 6. Analyze multirate digital filters for signal processing applications.					
Module:1	Discrete Signals, Systems and frequency analysis	6 hours			
Review of Discrete-Time Signals & Systems and frequency analysis - Z- transform: ROC stability/causality analysis, Frequency domain sampling - Sampling rate conversion - Aperiodic correlation estimation - Cepstrum processing - Band limited discrete time signals.					
Module:2	Discrete Fourier Transform, Properties and its applications	6 hours			
DFT – Properties - Linear filtering methods - Frequency analysis of signals using DFT - FFT Algorithm - Radix-2 FFT - Sparse FFT - Practical applications.					
Module:3	Design of Analog Filters	6 hours			
Design techniques for analog filter - Butterworth and Chebyshev approximations - Frequency transformation, Properties - Constant group delay and zero phase filters.					
Module:4	Digital transformation of IIR filters	5 hours			
IIR filter design: Bilinear transformation, Impulse Invariance - Spectral transformation of Digital filters					
Module:5	Design of FIR filters	5 hours			
FIR Filter Design: Design characteristics of FIR filters with linear-phase – Frequency response of linear phase FIR filters – Design of FIR filters using windowing techniques: Rectangular, Bartlett Hamming, Hanning, Blackmann, Kaiser - Phase delay, Group delay					
Module:6	Realization structures for Discrete-Time Systems	7 hours			
Direct, Cascade, Parallel, Lattice and Lattice - Ladder Structures: All pass filter - IIR tapped- cascaded structure. Parallel all pass realization of IIR systems.					
Module:7	Multirate digital signal processing	8 hours			
Introduction-Implementation of Sampling Rate Conversion: Polyphase Filter Structures - Interchange of Filters and Down samplers / Up samplers - Polyphase Structures for Decimation and Interpolation Filters - Structures for Rational Sampling Rate Conversion. Discrete Cosine Transform - Wavelet Transform					
Module:8	Contemporary issues	2 hours			
	Total Lecture hours:	45 hours			
Text Book(s)					
1.	John G. Proakis, Dimitris G Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 2022, 5 th Edition, Pearson, USA				
Reference Books					

Course code	Course Title	L	T	P	C
BECE301P	Digital Signal Processing Lab	0	0	2	1
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To learn the usage of appropriate tools for realizing signal processing modules.					
Course Outcome					
At the end of the course, the student will be able to					
1. Analyze real time and standard signals using DSP processor.					
2. Simulate the sampling and reconstruction of signals for digital signal processing					
3. Analyse the system stability using transformation techniques.					
Indicative Experiments					
1.	Introduction to TMS320C6748 processor and code composer studio IDE.				2 hours
2.	Generation of elementary signals and illustration of simple signal processing operations on TMS320C6748 processor				6 hours
3.	Sampling and Reconstruction of CT signals, DTFT analysis				6 Hours
4.	Biomedical / Speech / Audio Signal Analysis				6 Hours
5.	Computational analysis using FFT				3 Hours
6.	Design of IIR filter				3 Hours
7.	Design of FIR filter using windowing techniques				4 Hours
Total Laboratory Hours					30 Hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Analyze real time and standard signals using DSP processor.	-	3	-	-	3	-	-	-	2	2	-	-	-	3	-
CO2	Simulate the sampling and reconstruction of signals for digital signal processing	3	-	-	-	3	-	-	-	2	2	-	2	-	3	-
CO3	Analyse the system stability using transformation techniques.	-	3	-	-	-	-	-	-	2	2	-	-	-	3	-

Course Code	Course Title	L	T	P	C
BECE302L	Control Systems	2	1	0	3
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					

Course Code	Course Title	L	T	P	C
BECE303L	VLSI System Design	3	0	0	3
Pre-requisite	BECE204L, BECE204P	Syllabus version			
		1.0			
Course Objectives:					
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Course Code	Course Title	L	T	P	C
BECE303P	VLSI System Design Lab	0	0	2	1
Pre-requisite	BECE204L, BECE204P	Syllabus version			
		1.0			
Course Objectives:					
The objective of this laboratory is to apply the theoretical knowledge and explore various design style of CMOS Integrated Circuits (IC) design using the latest EDA tools					
Course Outcome:					
At the end of the course, the student will be able to					
- Employ CMOS principles to determine the performance of MOS devices, CMOS inverters under different sizing and biasing conditions. - Apply the CMOS design rules to realize combinational, sequential, arithmetic Circuit and semiconductor memory cell using different logic families. - Use CMOS layout guidelines to create CMOS inverter, universal and basic logic gates layouts and verify them using DRC and LVS.					
Indicative Experiments					
1	Parameter extraction for basic cell structure (NMOS and PMOS devices). Analysis of MOS with width variation, body effect and estimation of channel length modulation	2 hours			
2	Design and Analysis of CMOS inverter for arbitrary sizing. - Estimation of Power, Delay, Noise Margin. - Impact of load on performance metrics.	4 hours			
3	Analysis of CMOS inverter for given specification. Impact of sizing on Power, Delay, Noise Margin	2 hours			
4	Analysis of inverter chains using progressive sizing to improve delay performance.	2 hours			
5	Design and Analysis of Universal gates in static CMOS logic Effect of input reordering.	2 hours			
6	Design and Analysis of Boolean Expression (Simple Arithmetic Unit) in static CMOS logic.	2 hours			
7	Design and Analysis of Pass transistor and Transmission gate based circuits	4 hours			
8	Design and Analysis of CMOS sequential circuits (Latches and Flip Flops)	4 hours			
9	Design a CMOS Memory cell (SRAM, DRAM) and verify its operation.	4 hours			
10	Design Layout of CMOS inverter and perform post-layout analysis, DRC, Layout Vs. Schematic, Monte Carlo analysis, Corner analysis and etc.	4 hours			
Total Laboratory Hours		30 hours			
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Employ CMOS principles to determine the performance of MOS devices, CMOS inverters under different sizing and biasing conditions	3	-	-	-	3	-	-	-	2	2	-	-	3	-	-
CO2	Apply the CMOS design rules to realize combinational, sequential, arithmetic Circuit and semiconductor memory cell using different logic families.	3	-	-	-	3	-	-	-	2	2	-	-	3	-	-
CO3	Use CMOS layout guidelines to create CMOS inverter, universal and basic logic gates layouts and verify them using DRC and LVS	3	-	-	-	3	-	-	-	2	2	-	-	3	-	-

Course Code	Course Title	L	T	P	C
BECE304L	Analog Communication Systems	3	0	0	3
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives:					
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Course Code	Course Title	L	T	P	C
BECE304P	Analog Communication Systems Lab	0	0	2	1
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives:					
1. Procedurally troubleshoot, construct and analyse modulators and demodulators in analog communication systems.					
2. Examine the effect of modulation index and noise in analog communication systems.					
3. Inculcate hands-on experience, by integrating theory into practical experiments.					
Course Outcome:					
At the end of the course, the student will be able to					
1. Construct analog modulator and demodulator circuits using electronic components and measuring instruments.					
2. Demonstrate pulse modulation schemes and multiplexing techniques.					
3. Simulate the noise performance of analog communication receivers.					
Indicative Experiments					
1.	Design of AM, DSB-SC, SSB-SC modulators and demodulators				8 Hours
2.	Design of FM, PM modulators and demodulators				4 Hours
3.	Design of Superheterodyne receiver - Mixer, Pre-emphasis and De- emphasis				4 Hours
4.	Analyse the noise characteristics of analog communication systems – SNR, Noise voltage, Noise figure and Noise temperature				4 Hours
5.	Design of PAM, PPM, PWM modulators and demodulators				6 Hours
6.	Implementation of TDM and FDM				4 Hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Construct analog modulator and demodulator circuits using electronic components and measuring instruments.	3	-	-	-	-	-	-	-	2	2	-	-	-	3	-
CO2	Demonstrate pulse modulation schemes and multiplexing techniques.	3	-	-	-	-	-	-	-	2	2	-	-	-	3	-
CO3	Simulate the noise performance of analog communication receivers.	3	-	-	-	3	-	-	-	2	2	-	-	-	3	-

Course Code	Course Title	L	T	P	C
BECE305L	Antenna and Microwave Engineering	3	0	0	3
Pre-requisite	BECE205L	Syllabus version			
		1.0			
Course Objectives					
1. To introduce and discuss the mechanism for antenna parameters, radiating principles, fundamental characteristics and design concepts of HF, UHF, Microwave antennas and arrays. 2. To design and analyse various passive and active microwave circuits. 3. To familiarize the operational principles of microwave sources and to characterize microwave networks.					
Course Outcome					
At the end of the course, the student will be able to					
1. Determine antenna parameters using radiation principles. 2. Analyze antenna arrays and various directional antennas for wireless applications. 3. Illustrate the S-parameters of microwave sources in RF measurement. 4. Analyze the characteristics of passive waveguide components using S-parameters. 5. Analyze the various passive circuits at microwave frequencies 6. Design microwave active circuits for high frequency applications.					
Module:1	EM Radiation and Antenna Parameters	8 hours			
Radiation mechanism - single wire, two wire and current distribution, Hertzian dipole, Dipole and monopole - Radiation pattern, beam width, field regions, radiation power density, radiation intensity, directivity and gain, bandwidth, polarization, input impedance, efficiency, antenna effective length and area, antenna temperature. Friis transmission equation, Radar range equation.					
Module:2	Linear and Planar Arrays	6 hours			
Two element array, N-element linear array - broadside array, End fire array - Directivity, radiation pattern, pattern multiplication.Non-uniform excitation - Binomial, Chebyshev distribution, Arrays: Planar array, circular array, Phased Array antenna (Qualitative study).					
Module:3	HF, UHF and Microwave Antennas	7 hours			
Wire Antennas - long wire, loop antenna - helical antenna. Yagi-Uda antenna, Frequency independent antennas - spiral and log periodic antenna - Aperture antennas – Horn antenna, Parabolic reflector antenna - Microstrip antenna.					
Module:4	Microwave Sources	5 hours			
Microwave frequencies and applications, Microwave Tubes: TWT, Klystron amplifier, Reflex Klystron & Magnetron. Semiconductor Devices: Gunn diode, Tunnel diode, IMPATT – TRAPATT - BARITT diodes, PIN Diode.					
Module:5	Microwave Passive components	6 hours			
Microwave Networks - ABCD, ‘S’ parameter and its properties. E-Plane Tee, H-Plane Tee, Magic Tee and Multi-hole directional coupler. Principle of Faraday rotation, isolator, circulator and phase shifter.					
Module:6	Microwave Passive circuits	7 hours			
T junction and resistive power divider, Wilkinson power divider, branch line coupler (equal & unequal), Rat Race Coupler, Filter design: Low pass filter (Butterworth and Chebyshev) - Richard’s transformation and stepped impedance methods.					
Module:7	Microwave Active Circuits	4 hours			
Microwave transistors, Microwave amplifiers: Two port power gains, stability of the amplifier, Microwave oscillators.					
Module:8	Contemporary issues	2 hours			
	Total Lecture hours:	45 hours			
Text Book(s)					

Course Code	Course Title	L	T	P	C
BECE305P	Antenna and Microwave Engineering Lab	0	0	2	1
Pre-requisite	BECE205L	Syllabus version			
		1.0			
Course Objectives					
1. To apply the theoretical knowledge and explore the designing principles of various antennas and microwave devices.					
2. To design the various microwave antenna and devices using a suitable design tool.					
Course Outcome					
At the end of the course, the student will be able to					
1. Measure the radiation characteristics of antennas and S-parameters of microwave components.					
2. Simulate the performance metrics of microwave passive circuits.					
3. Determine the performance parameters of microwave antennas at specified operating frequencies.					
Indicative Experiments					
Hardware Experiments:					
1.	Measurement of antenna input impedance				2 hours
2.	Measurement of antenna radiation pattern				2 hours
3.	Measurement of S-parameters for E-plane, H-plane and Magic Tee				4 hours
4.	Measurement of S-parameters for Directional Coupler				2 hours
5.	Measurement of S-parameters for Isolator and Circulator				2 hours
6.	Measurement of S-parameters of MIC devices				4 hours
Experiments using Simulation tools:					
7.	Design of Wilkinson power divider				2 hours
8.	Design of branch line and Rat race coupler				2 hours
9.	Design of low pass filters: Richards and Stepped impedance method				2 hours
10.	Design of matching circuits using quarter wave & single stub.				4 hours
11.	Design of dipole antenna				2 hours
12.	Design of Rectangular patch antenna				2 hours
Total Laboratory Hours		30 hours			
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Measure the radiation characteristics of antennas and S-parameters of microwave components.	3	-	-	-	-	-	-	-	2	2	-	-	-	3	-
CO2	Simulate the performance metrics of microwave passive circuits.	3	-	-	-	3	-	-	-	2	2	-	-	-	3	-
CO3	Determine the performance parameters of microwave antennas at specified operating frequencies.	3	-	-	-	3	-	-	-	2	2	-	-	-	3	-

Course Code	Course Title	L	T	P	C
BECE306L	Digital Communication Systems	3	0	0	3
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives:					
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Course Code	Course Title	L	T	P	C
BECE306P	Digital Communication Systems Lab	0	0	2	1
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives					
1. To implement various waveform coding techniques. 2. To analyze various baseband and bandpass signals for effective communication. 3. To understand the principles and importance of multiple access techniques in the context of communication.					
Course Outcome					
At the end of the course, the student will be able to 1. Implement digital modulation techniques using electronic components and measuring instruments. 2. Simulate baseband and passband digital communication techniques using MATLAB. 3. Compute the performance metrics of spread-spectrum techniques for wireless communication applications.					
Indicative Experiments					
1.	Generation and reconstruction of PCM, DPCM and DM				4 Hours
2	Generation of baseband signals using various line coding formats for the given binary sequence				4 Hours
3.	Generation and detection of bandpass modulation techniques				12 Hours
4.	BER analysis of bandpass modulation techniques				2 Hours
5	Generation of PN sequence and verification of its properties				4 Hours
6.	Implementation of multiple access schemes				4 Hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Implement digital modulation techniques using electronic components and measuring instruments.	3	-	-	-	-	-	-	-	2	2	-	-	-	3	-
CO2	Simulate baseband and passband digital communication techniques using MATLAB.	3	-	-	-	3	-	-	-	2	2	-	2	-	3	-
CO3	Compute the performance metrics of spread-spectrum techniques for wireless communication applications.	3	-	-	-	3	-	-	-	2	2	-	-	-	3	-

Course Code	Course Title	L	T	P	C
BECE317L	Wireless and Mobile Communications	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives:					
1. To familiarize the concepts of wireless communication. 2. To teach students the fundamentals of multipath fading and propagation models. 3. To acquaint students with different generations of mobile networks. 4. To describe the diversity and MIMO schemes as applied in wireless communication.					
Course Outcome:					
At the end of the course, the student will be able to					
1. Compute the effect of large- and small-scale fading on communication system performance. 2. Apply wireless communication techniques to different wireless systems and standards. 3. Analyze the performance metrics of orthogonal frequency division multiplexing 4. Apply diversity techniques to reduce the effect of multipath fading 5. Analyze power allocation and detection techniques in MIMO system. 6. Illustrate the architecture and operation of next generation wireless communication systems.					
Module:1	Mobile Radio Propagation: Large Scale Fading	6 hours			
Overview of Wireless Communication, Cellular concept – Frequency reuse – Channel assignment strategies – Handoff strategies – Interference and system capacity – Trunking and grade of service – Improving coverage and capacity in cellular system. Propagation mechanisms, Free space model, Two ray model, Outdoor and indoor propagation models, Link budget design.					
Module:2	Mobile Radio Propagation: Small Scale Fading	4 hours			
Small scale multipath propagation, Parameters of multipath channels, Types of small-scale fading, Rayleigh and Rician fading.					
Module:3	Wireless Systems and Standards	3 hours			
AMPS, GSM, GPRS, EDGE, UMTS, LTE, LTE-A.					
Module:4	OFDM Technology	3 hours			
Introduction and Challenges in Multicarrier Systems, OFDM System Model - IFFT/ FFT Transceiver Mathematical Model - Cyclic Prefix, PAPR and reduction techniques - SNR and BER performance - ICI-SC-FDMA.					
Module:5	Diversity Techniques	4 hours			
Multiple Antenna Wireless Systems-System Model, Types of Diversity: Antenna, Frequency, Time; Deep Fade Analysis with Diversity, Optimal Receiver Combining, MRC, EGC, Diversity Order.					
Module:6	MIMO Technology	5 hours			
MIMO System Model – Zero Forcing and Minimum Mean Square Error receivers – Singular Value Decomposition - Channel Capacity - Optimal Water filling Power Allocation - Beam forming - Spatial Multiplexing, BLAST Architectures, Distributed MIMO.					
Module:7	Next Generation Wireless Communication	3 hours			
5G Wireless Technologies - NR Standard, filter bank multicarrier, non-orthogonal multiple access, D2D, small cells, mm-Wave, Index Modulation - 6G Key enablers – Reconfigurable intelligent surfaces.					
Module:8	Contemporary issues	2 hours			
	Total Lecture hours:	30 hours			
Text Book(s)					
1.	Rappaport, T.S., Wireless Communications: Principles and Practice, 2018, (Reprint), Pearson Education, Noida, India.				

Course Code	Course Title	L	T	P	C
BECE317P	Wireless and Mobile Communications Lab	0	0	2	1
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. To analyse the fundamentals of multipath fading and propagation models. 2. To understand the principles of multicarrier modulation. 3. To demonstrate the diversity techniques and MIMO Technology.					
Course Outcome					
At the end of the course, the student will be able to 1. Simulate wireless channel modelling using different path loss. 2. Analyze performance of multicarrier modulation schemes. 3. Implement diversity and spatial multiplexing techniques in MIMO based wireless applications.					
Indicative Experiments					
1.	Study how call blocking probability varies as the load on a GSM network is continuously increased using Network Simulator				4 Hours
2.	To study the effect of various fading channels such as Rayleigh, Rician and various noise channel such as AWGN and Laplacian noise				4 Hours
3.	Simulate to compute the pathloss of urban, suburban and rural environment for LTE/WiMAX/WLAN system using free space, Ericsson, COST 231, ECC, Hata and SUI model				4 Hours
4.	Testing and validating principles of Pathloss in Mobile Radio Propagation through Smartphone and CRFO				2 Hours
5.	Throughput analysis of LTE network with respect to varying distance between the ENB and UE (User Equipment)				2 Hours
6	Write a program to analyse the Bit Error Rate (BER) performance of OFDM using BPSK, QPSK and QAM modulation schemes.				4 Hours
7.	Write a program to analyse the following techniques to reduce the PAPR in OFDM. (i) Selective Mapping (SLM) technique (ii) Partial Transmit (PTM) Technique. (iii) Windowing Technique.				2 Hours
8.	Comparison of MRC and EGC schemes with SISO fading				2 Hours
9.	Comparison of ZF and MMSE MIMO receivers				4 Hours
10	HF Radio Channel Simulation using a real-time radio simulator				2 Hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Simulate wireless channel modelling using different path loss.	3	-	-	-	3	-	-	2	2	-	-	-	-	3	-
CO2	Analyze performance of multicarrier modulation scheme	-	3	-	-	3	-	-	2	2	-	-	-	-	3	-
CO3	Implement diversity and spatial multiplexing techniques in MIMO based wireless applications	3	-	-	-	3	-	-	2	2	-	-	-	-	3	-

Course Code	Course Title	L	T	P	C
BECE318L	Optical Fiber Communications	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. To understand the principles of optical fibers and their signal degradation. 2. To familiarize with the fundamentals of optical sources and detectors used in communications. 3. To learn WDM techniques and its components in contemporary optical communication systems.					
Course Outcomes					
At the end of the course, the student will be able to 1. Apply optical laws to model the fiber structures and waveguides. 2. Determine the effects of signal degradation and nonlinearities in optical fibers. 3. Analyze the performance of optical sources and detectors. 4. Compute the link-budget and rise-time budget of optical communication systems. 5. Illustrate the architecture and operation of wavelength-division multiplexing using optical components. 6. Illustrate the functionality and characteristics of optical amplifiers in optical communication systems.					
Module:1	Optical Fiber: Structures, Waveguides	3 hours			
Key elements of optical fiber system-Ray optics, Mode theory, Geometrical-Optics Description, Fiber Types - specialty fibers.					
Module:2	Signal Degradation	5 hours			
Attenuation-Absorption, Scattering, Bending losses, Dispersion-Material, Waveguide Dispersion, Polarization Mode Dispersion, Intermodal dispersion, Mode Transit time, Dispersion-Induced Limitations, Nonlinear Optical Effects- SRS, SBS, SPM, CPM, FWM.					
Module:3	Optical Transmitters	4 hours			
Sources: LED-Structures-Quantum Efficiency, Power and Modulation Bandwidth- LASER- DFB, DBR, VCSEL, Quantum Efficiency, Modulators - Direct and external modulators, Transmitter Design.					
Module:4	Optical Receivers	5 hours			
Photodetector-PIN, APD, Receiver Design, Receiver Noise-CNR&SNR), Receiver Sensitivity, Quantum limit, Sensitivity Degradation, Receiver Performance-Probability of error, Bit Error rate, Eye-Diagram.					
Module:5	Digital links and Measurements	4 hours			
Digital links: Point-to-Point Links-System Consideration-Link power budget-Rise time budget, System performance- Attenuation, Dispersion measurements-OTDR.					
Module:6	WDM Concepts and Components	5 hours			
Overview of WDM, Fiber Coupler-Wave guide coupler-Star couplers, Isolators and Circulators - Fiber Bragg Grating, Filters, Multiplexers, WDM System Performance Issues- Compensation techniques.					
Module:7	Optical Amplifiers	2 hours			
Semiconductor Optical Amplifiers, Raman Amplifiers, Erbium-Doped Fiber Amplifiers.					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:	30 hours			
Text Book(s)					
1.	Gerd Keiser, Optical Fiber Communications, 2017, 5 th Edition, McGraw Hill Education, India.				
Reference Books					

Course Code	Course Title	L	T	P	C
BECE318P	Optical Fiber Communications Lab	0	0	2	1
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. To design the optical communication system and study the signal degradation. 2. To familiarize wavelength division multiplexing techniques and associate components. 3. To estimate the link power budget and rise time budget.					
Course Outcome					
At the end of the course, the students will be able to 1. Simulate optical transmission links using direct and external modulation for different wavelengths and data formats. 2. Implement optical amplifier and WDM configurations for optical link performance measurement 3. Perform optical link configurations for dispersion compensation, power budgeting and component characterization.					
Indicative Experiments					
1.	Design of optical transmission link to analyse the BER performance for different line coding techniques, modulation based on wavelength and length of the fiber.				6 hours
2.	Design and analysis of gain, noise figure and saturation of optical amplifier – EDFA, SOA.				4 hours
3.	Performance analysis of wavelength division multiplexing (WDM) techniques and passive optical components (Optical coupler, Isolator, Circulator, FBG & OADM)				8 hours
4.	Analyse the different dispersion compensation techniques and fiber non- linear effects.				8 hours
5.	Design of point-to-point optical system, estimate the power and rise-time budget and detect the fiber faults using OTDR.				4 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Simulate optical transmission links using direct and external modulation for different wavelengths and data formats.	3	-	-	-	3	-	-	2	2	-	-	-	-	3	-
CO2	Implement optical amplifier and WDM configurations for optical link performance measurement	3	-	-	-	-	-	-	2	2	-	-	-	-	3	-
CO3	Perform optical link configurations for dispersion compensation, power budgeting and component characterization.	3	-	-	-	-	-	-	2	2	-	-	-	-	3	-

Course Code	Course Title	L	T	P	C
BECE401L	Computer Communications and Networks	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus Version			
		1.0			
Course Objectives:					
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2.	W. Stallings, Data and Computer Communications, 2017, 10 th Edition, Pearson Prentice Hall, USA.		
3.	Behrouz A Forouzan, Data Communications and Networking, 2017, 5 th Edition, Tata McGraw-Hill, USA.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Illustrate the functions of network reference models and behavior of Internetworking devices	3	-	-	-	-	-	-	-	-	-	-	-	-	3	2
CO2	Apply error detection techniques, framing methods, and data link layer protocols for reliable data transmission	3		-	-	-	-	-	-	-	-	-	-	-	3	2
CO 3	Analyze the performance of Medium Access Control protocol	-	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO 4	Apply subnetting techniques and routing algorithms for efficient packet delivery	3	-	-	-	-	-	-	-	-	-	-	-	-	3	2
CO 5	Analyze transport layer protocols and their mechanisms for reliable and efficient data transmission	-	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO 6	Comprehend and make effective reports/ presentations in networking technologies	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-

Course Code	Course Title	L	T	P	C
BECE401P	Computer Communications and Networks Lab	0	0	2	1
Pre-requisite	BECE306L, BECE306P	Syllabus Version			
		1.0			
Course Objectives:					
1. To familiarize the students with the basic terminologies and concepts of OSI, TCP/IP reference model and functions of various layers. 2. To make the students understand the design and performance issues associated with the functioning of LANs and WLANs. 3. To introduce the students to analyze the IP addressing and basics of transport and application layer protocols.					
Course Outcome:					
At the end of the course, the students will be able to					
1. Analyze the performance of internetworking devices and network topologies using simulation tools. 2. Analyze the performance of data link control protocols using simulation tools. 3. Implement routing algorithms to compute the shortest path using simulation tools.					
List of Challenging Experiments (Indicative)					
Task 1	Simulation and performance analysis (in terms of PDR, delay) of different network topologies and queuing mechanisms.				6 hours
Task 2	Analyze the spanning tree algorithm by varying the priority among the switches.				4 hours
Task 3	Simulation of framing and error detection schemes.				4 hours
Task 4	Simulation and performance analysis of different Medium Access Control schemes.				4 hours
Task 5	Implementation of various routing algorithms to compute the shortest path.				6 hours
Task 6	Analysis of transport layer protocols and congestion control.				6 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Analyze the performance of internetworking devices and network topologies using simulation tools.	-	3	-	-	3	-	-	-	2	2	-	-	-	3	2
CO2	Analyze the performance of data link control protocols using simulation tools.	-	3	-	-	3	-	-	-	2	2	-	-	-	3	2
CO3	Implement routing algorithms to compute the shortest path using simulation tools.	3	3	-	-	3	-	-	-	2	2	-	-	-	3	2

Course Code	Course Title	L	T	P	C
BECE208E	Data Structures and Algorithms	2	0	2	3
Pre-requisite	BCSE101E	Syllabus version			
		1.0			
Course Objectives					
1. To emphasize the scope and significance of Data Structures and Algorithms for real world problems. 2. To enable a good understanding of the fundamental data structures. 3. To enable a study of algorithms for various kinds of applications. 4. To impart skill to theoretically analyze and evaluate performance of algorithms					
Course Outcome					
At the end of the course, students will be able to					
1. Utilize appropriate data structures to develop solution for the given problems. 2. Implement efficient algorithms using data structure concepts. 3. Apply different algorithms to process and manage various data types. 4. Demonstrate the use of data-structure techniques for organizing large data sets. 5. Employ algorithms and data structures to solve real-world problems. 6. Apply appropriate data structures to provide software solutions for addressing different application requirements.					
Module:1	Implementing Data Structures	5 hours			
Linked list, Stack, Queues, Trees, Maps, Hash Tables.					
Module:2	Algorithm Analysis	3 hours			
Analysis Algorithms - Asymptotic notations – Recurrences -Substitution - Recursion-tree – The master method					
Module:3	Algorithms with Numbers	3 hours			
Sorting and Searching- Insertion sort, Binary Search, Divide and Conquer Algorithms-Merge sort, Quick Sort.					
Module:4	Algorithms on Strings	4 hours			
Pattern Matching- KMP, Rabin-karp algorithm, Huffman Encoding.					
Module:5	Graph Algorithms	5 hours			
Decomposition of graphs, Paths in graphs: BFS & DFS, Minimum Spanning Algorithms: Prim's & Kruskal's - Single-Source (Dijkstra's) & All-pairs (Floyd & Warshall's).					
Module:6	Algorithms for Optimization	5 hours			
Brute force, Dynamic programming, Greedy algorithms: Fractional Knapsack & Linear programming.					
Module:7	Search Heuristics	3 hours			
Introduction to NP Completeness, Search Heuristics, Intelligent exhaustive search, Local search heuristics.					
Module:8	Contemporary issues	2 hours			
	Total Lecture hours:	30 hours			
Text Book(s)					
1.	Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, MIT Press, Fourth edition ,2022				
2.	Mark A. Weiss, Data Structures & Algorithm Analysis in C++, 4th Edition, 2013, Pearson Education.				
Reference Books					
1.	Michael T Goodrich, Roberto Tamassia & Michael H Goldwasser, Data Structures and Algorithms in Java, Wiley 2014.				

2.	Kent. D. Lee, Steve Hubbard, Data Structures and Algorithms with Python, Springer, 2015.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Indicative Experiments			
1.	Implementing Linked list - Stacks & Queues, Trees, Maps & Hash Tables by demonstrating applications for each.		12 hours
2.	Performance evaluation of Divide and Conquer Algorithms		4 hours
3.	Text Processing - Compression & Encryption		4 hours
4.	Implementing Graph Algorithms		3 hours
5.	Implementation of Algorithms: Dynamic Programming, Greedy & Linear Programming		3 hours
6.	Search Algorithms		4 hours
Total Laboratory Hours			30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Utilize appropriate data structures to develop solution for the given problems.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	Implement efficient algorithms using data structure concepts.	3	-	-	-	2	-	-	-	-	-	-	-	-	-	2
CO3	Apply different algorithms to process and manage various data types.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO4	Demonstrate the use of data-structure techniques for organizing large data sets.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO5	Employ algorithms and data structures to solve real-world problems.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO6	Apply appropriate data structures to provide software solutions for addressing different application requirements.	3	-	-	-	3	-	-	-	2	2	-	-	-	-	2

Course Code	Course Title	L	T	P	C
BECE209E	Structured and Object-Oriented Programming	2	0	4	4
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
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1	Herbert Schildt, C: The Complete Reference, 2017, 4 th Edition, McGraw Hill Education.		
2	Herbert Schildt, C++: The Complete Reference, 2017, 4 th Edition, McGraw Hill Education.		
Reference Books			
1	Yashavant Kanetkar, Let Us C: 2020, 17 th Edition, BPB Publications, 2020.		
2	Stanley Lippman and Josee Lajoie, C++ Primer, 2012, 5 th Edition, Addison-Wesley publishers		
3	Byron S Gottfried, Programming with C, 2018, 2018, 4 th Edition, Schaum’s outline series.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Indicative Experiments			
1.	Programs using basic control structures, branching and looping		
2.	Experiment the use of 1-D, 2-D arrays and strings and Functions		
3.	Demonstrate the application of pointers		
4.	Experiment structures and unions		
5.	Programs on basic Object-Oriented Programming constructs.		
6.	Demonstrate various categories of inheritance		
7.	Program to apply kinds of polymorphism.		
8.	Develop generic templates and Standard Template Libraries.		
9.	Demonstrate the use of Exception handling.		
10.	Demonstrate the working of file handling.		
Total Hours			60 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	Apply branching and looping statements to process 1D and 2D arrays.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	2
CO 2	Use pointers to implement dynamic memory allocation and management.	2	-	-	-	3	-	-	-	-	-	-	-	-	-	2
CO 3	Apply structures and unions to represent different data types in programming.	2	-	-	-	3	-	-	-	-	-	-	-	-	-	2
CO 4	Apply polymorphism and inheritance which are imbibed in object-oriented programming.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	2
CO 5	Apply appropriate exception-handling methods to manage different exceptions.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	2
CO 6	Use file-handling mechanisms to perform reading and writing operations on files.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	2
CO 7	Implement object-oriented programming concepts using inheritance and polymorphism to develop practical applications.	3	-	-	-	3	-	-	-	2	2	-	-	-	-	2

Course Code	Course Title	L	T	P	C
BECE309L	Artificial Intelligence and Machine Learning	3	0	0	3
Pre-requisite	BMAT201L	Syllabus version			
		1.0			
Course Objectives					
1. To get acquainted with different types of intelligent agents. 2. To understand the importance and significance of Machine learning. 3. To preface the essentials of Deep Learning.					
Course Outcome					
At the end of the course, students will be able to					
1. Employ intelligent agents for different environment types. 2. Apply search algorithms to provide solutions for real-world problems. 3. Illustrate the concepts of knowledge-representation using proportional and first order logic for AI applications. 4. Apply the concepts of knowledge representation in uncertainty and decision-making techniques to solve the intelligent system problems. 5. Analyze machine learning techniques and data preparation methods for signal processing and intelligent antenna applications. 6. Analyze different deep learning algorithms for solving real-world problems.					
Module:1	Foundations of AI	4 hours			
Introduction – Agents and rationality – Task environment – Agent Architecture Types.					
Module:2	Problem-solving by Searching	7 hours			
Search Space – Search algorithms, strategies – Search in complex environments.					
Module:3	Knowledge Representation	6 hours			
Knowledge-based agents, Agents based on Propositional Logic – First-order logic.					
Module:4	Probability reasoning and uncertainty	6 hours			
Quantifying uncertainty, Knowledge representation in uncertainty, Decision making – Simple, complex.					
Module:5	Data Preparation for Machine Learning	4 hours			
Basics of Vectors & Matrices – Overview: Data Cleaning, Integration, Transformation & Reduction.					
Module:6	Learning from Examples	9 hours			
Forms of Learning – Dimensionality reduction - Regression – Statistical Methods: Naïve-Bayes, Nearest Neighbor, Decision Trees – Random Forest, Clustering, Ensemble Learning, Case studies – Machine Learning in Signal Processing, Intelligent Antenna.					
Module:7	Deep Learning	7 hours			
Simple Feed Forward Networks – Computational graphs for Deep Learning – Convolutional Networks – Recurrent Neural Networks – Kernel Machines – Hidden Markov Models.					
Module:8	Contemporary issues	2 hours			
	Total Lecture hours:	45 hours			
Text Book(s)					
1.	Stuart J Russell, Peter Norwig, Artificial Intelligence – A modern approach, 2015, 3 rd edition, Pearson, India.				

Reference Books

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| 1. | Vinod Chandra S.S, Anand Hareendran S., Artificial Intelligence: Principles and Applications, 2020, 2 nd Edition, PHI Learning Pvt. Ltd., India. |
| 2. | Alpaydin ethem, Introduction to Machine Learning, 2019, 3rd edition, PHI Learning Pvt. Ltd., India. |

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

Recommended by Board of Studies	14-05-2022
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Approved by Academic Council	No. 66	Date	16-06-2022
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Course Code	Course Title	L	T	P	C
BECE310L	Satellite Communications	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. To learn the conceptual knowledge of communication through satellites. 2. To provide a detailed understanding of navigation - both inertial and by navigation satellites. 3. To analyze typical challenges of satellite-based systems.					
Course Outcomes					
At the end of the course, students will be able to 1. Apply the concept of orbital mechanics to launch and position the satellites. 2. Determine the subsystem parameters of a satellite system. 3. Employ the digital transmission techniques in satellite communication systems. 4. Compute the link budget for satellite communication systems. 5. Illustrate the VSAT network architectures and NGSO satellite systems. 6. Determine the coverage and positioning parameters of direct broadcast satellite TV and global navigation satellite systems.					
Module:1	Orbital Mechanics	6 hours			
Overview of satellite communication - Orbital mechanics - Equations of the orbit - Kepler’s laws of planetary motion - Orbital elements - Look angle determination - Orbital perturbation and determination					
Module:2	Orbital Launchers	3 hours			
Launches and launch vehicles- Launch vehicle selection factors - Satellite positioning into geostationary orbit - Orbital effects in communication systems performance - Doppler shift -Range variations - Solar eclipse and sun transit outage.					
Module:3	Elements of Communication Satellite Design	5 hours			
Satellite subsystems - Attitude and orbit control electronics - Telemetry and tracking - Power subsystems - Communication subsystems - Satellite antennas - Reliability and redundancy- Frequency modulation techniques.					
Module:4	Digital Transmission Basics	4 hours			
Modulation and Multiplexing -Multiple access techniques – FDMA, TDMA, CDMA, SDMA, ALOHA and its types – Onboard processing- Satellite switched TDMA – Spread spectrum transmission and reception for satellite networks.					
Module:5	Satellite Link Design	9 hours			
Basic transmission theory – System noise temperature and G/T Ratio- Noise figure and noise temperature- Calculation of system noise temperature – G/T ratio for earth stations - Link budgets - Uplink and downlink budget calculations - Error control for digital satellite links - Prediction of rain attenuation and propagation impairment counter measures.					
Module:6	VSAT and NGSO System	7 hours			
Overview of VSAT systems-VSAT Network Architectures, One Way Implementation, Two-Way Implementation, Delay Considerations, VSAT Earth Station Engineering -NGSO Satellite Systems Constellation/ Constellation Design Considerations - Starlink, One Web					
Module:7	Direct Broadcast Satellite Television systems and GPS	9 hours			

Course Code	Course Title	L	T	P	C
BECE311L	Radar Systems	3	0	0	3
Pre-requisite	BECE305L, BECE305P	Syllabus version			
		1.0			
Course Objectives					
1. To understand and analyze various radar parameters.					
2. To analyze and design transmitter, receiver circuits and antennas for various radars.					
3. To understand and contrast the need for modern radars for different applications.					
Course Outcomes					
At the end of the course, students will be able to					
1. Apply the principles of radar to estimate the range and detect the target.					
2. Compute the transmitter parameters of the radar system.					
3. Illustrate the operations and functionalities of the radar transceiver.					
4. Employ various signal and data processing techniques to recover the signal.					
5. Determine the different antennas parameters for radar applications.					
6. Employ different types of radar systems and stealth technology techniques.					
Module:1	Principles of Radar	6 hours			
Introduction to Radars, Radar principle, Doppler Effect, Radar frequency bands, Radar Block Diagram, Radar Range Equation, Radar Cross section of targets, Radar Clutter, types of scattering, Applications of Radars					
Module:2	Radar Parameters	6 hours			
Transmit pulse width, Pulse Repetition Frequency, baud length, range resolution, unambiguous range, coherent integration, FFT points, incoherent integration, detectability, SNR, receiver bandwidth, Transmit power, Pulse compression techniques.					
Module:3	Transmit and Receive modules (TRM)	8 hours			
Block schematic, Timing and signal generation for TRM operation, Gain and phase control, Design of power amplifiers, Transmit-receive switch, circulator, blanking switch, types of amplifiers (linear amplifiers, low noise amplifiers and solid-state amplifiers), and band pass filter.					
Module:4	Signal & Data Processing	6 hours			
Digital receiver and signal processing steps, DC and clutter removing, spectrum cleaning, computation of spectral moments, computation of velocity, range time intensity (SNR) computation, cross correlation and autocorrelation, capon imaging, maximum entropy method for imaging.					
Module:5	Radar Antennas	8 hours			
Antenna parameters for Radars, Parabolic Reflector antenna, Yagi-Uda antenna, Microstrip patch antenna, phased array system: Planar Arrays, Electronic beam steering, Beam forming, Phase Shifters, Active Phased array and semi active phased array system, Radomes.					
Module:6	Types of Radars	6 hours			
Principle of operation, Block diagram, Advantages, limitations and Application of CW Radar, Pulsed Radar, MTI Radar, Synthetic Aperture Radar, and Meteorological Radars (MST and Doppler weather radar).					
Module:7	Stealth Technology	3 hours			
Principles, Radar cross section reduction, RF absorbers and Radar stealth countermeasures and limits.					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:	45 hours			

Course Code	Course Title	L	T	P	C
BECE312L	Robotics and Automation	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To provide basic understanding of robotics and automation. 2. To demonstrate the need of various sensors and drives in robotic system. 3. To make students understand about the robotic kinematics, path planning and different trajectories. 4. To deliver the programming languages to design robots in practice and research for contemporary use.					
Course Outcomes					
At the end of the course, students will be able to					
1. Employ different types of robots based on their performance characteristics. 2. Illustrate the functions of drivers and actuators in robotics. 3. Demonstrate the role of various sensors for robotic applications. 4. Apply kinematics and linear dynamics to manipulate robots. 5. Illustrate types of trajectories and path planning in robotic systems. 6. Analyze the functionality of robotic systems for various applications using suitable programming languages and software packages.					
Module:1	Robotics and Automation	5 hours			
Robots: Basics, Types-Application, Mobility, DoF, Terrain, components classification, performance characteristics, Industrial Robots, HRI, Automatic assembly system.					
Module:2	Drives for Robotics	5 hours			
Drives: Electric, hydraulic and pneumatic drives.					
Module:3	Sensors for Robots	7 hours			
Tactile sensors - Proximity and range sensors – Optical Sensor- limit switch sensor- surface array sensor- Acoustic sensors - Vision sensor systems – Vision feedback system -Image processing and analysis - Image data reduction – Segmentation – Feature extraction -Object recognition.					
Module:4	Robot Kinematics and Dynamics	10 hours			
Kinematics of manipulators, rotational, translation and transformation Homogeneous, Transformations, Denavat - Hartenberg Representation, Inverse Kinematics. Linearization of Robot Dynamics – State variable continuous and discrete models.					
Module:5	Path Planning	5 hours			
Types of trajectories, trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion and straight-line motion.					
Module:6	Programming of Robots	5 hours			
Robot programming: ROS1 and ROS2, languages and software packages- MATLAB/Simulink, Open RDK, Adams.					
Module:7	Application of Robots	6 hours			
Industrial robots used for welding, painting and assembly, remote controlled robots, robots for nuclear, thermal and chemical plants, industrial automation, typical examples of automated Industries, Humanoid robots, medical robots, under water robots, drones.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:			
		45 hours			
Text Book(s)					

Course Code	Course Title	L	T	P	C
BECE313L	Information Theory and Coding	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. This course provides an understanding of fundamental information theoretic techniques including applications to compression and error control coding. 2. It also aims at quantitative measure of information may be used in order to build efficient solutions to multitudinous engineering problems.					
Course Outcomes					
At the end of the course, students will be able to					
1. Apply probability theory to calculate entropies and mutual information. 2. Compute channel capacity for various communication channels. 3. Analyze source coding algorithms for effective and efficient compression. 4. Apply various coding techniques and standards for audio and video signals. 5. Use different channel coding techniques for reliable communication. 6. Employ LDPC and Polar coding schemes for 5G channel coding.					
Module:1	Information Measures	7 hours			
Review of Probability Theory, Introduction to information theory, Uncertainty, self- information, average information, Marginal Entropy, Joint Entropy and Conditional Entropy, Mutual Information, Relationship between entropy and mutual information and their properties, Markov statistical model for information source, Entropy and information rate of Markov source, Information measures of continuous random variables.					
Module:2	Channel Models and Capacity	6 hours			
Importance and types of various channel models - Channel capacity calculation – Binary symmetric channel, binary erasure channel - Shannon’s channel capacity and channel coding theorem - Shannon’s limit.					
Module:3	Probability based Source Coding	6 hours			
Source coding theorem - Huffman coding - Non binary Huffman codes - Adaptive Huffman coding - Shannon Fano Elias coding - Non binary Shannon Fano codes, Arithmetic coding					
Module:4	Non-Probability based Source Coding	5 hours			
Lempel-Ziv coding, Run-length encoding and rate distortion function - Transform coding - JPEG and JPEG 2000.					
Module:5	Audio and Video Coding	5 hours			
Audio Coding: types – Linear Predictive Coding (LPC) – Code Excited LPC – Perceptual Coding - MPEG Audio Coding. Video Coding: Motion Estimation and Compensation – Types of Frames – Encoding and Decoding of Frames – Video Coding Standard: MPEG 4.					
Module:6	Channel Coding	9 hours			
Introduction to Error control codes - Block codes, linear block codes, cyclic codes and their properties, Encoder and Decoder design- serial and parallel concatenated block code, Convolution Codes- Properties, Encoder-Tree diagram, Trellis diagram, state diagram, transfer function of convolutional codes, Viterbi Decoding, Trellis coding, Reed Solomon codes, Turbo coder, Iterative Turbo decoder.					
Module:7	Channel Coding for 5G standard	5 hours			
Low Density Parity Check code - LDPC code construction, construction in 5G standard, encoding of LDPC codes, Message passing decoding on Tanner graph. Polar code – Representation, generator matrix, Successive cancellation decoder for polar codes.					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:	45 hours			

Text Book(s)			
1	Simon Haykin, “Communication Systems”, 2017, 5 th Edition, Wiley India Pvt Ltd, India.		
2	Khalid Sayood, “Introduction to Data Compression, 5 th Edition, The Moragan Kaufmann Series in Multimedia Information and Systems, Elsevier, 2017.		
Reference Books			
1.	Ranjan Bose, “Information Theory, Coding and Cryptography”, 2015, 1 st Edition, McGraw Hill Education (India) Pvt. Ltd., India.		
2	Murlidhar Kulkarni, K.S. Shivaprakasha, “Information Theory and Coding As per AICTE”, 2019, 2 nd Edition, Wiley India Pvt Ltd, India.		
3	Orhan Gazi, “Polar Codes: A Non-Trivial Approach to Channel Coding”, 2019, 1st Edition, Springer Topics in Signal Processing Book 15.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-02-2023	
Approved by Academic Council		No. 69	Date 16-03-2023

[illegible]

Course Code	Course Title	L	T	P	C
BECE314L	Electromagnetic Interference and Compatibility	2	1	0	3
Prerequisite	BECE205L	Syllabus Version			
		1.0			
Course Objectives					
1. To understand importance of EMC and EMC compliance for the products. 2. To understand guidelines for reduced EMI in PCB design 3. To learn the EMI sources, mitigation, and measurement techniques/standards to guarantee the correct working modalities.					
Course Outcomes					
At the end of the course, students will be able to 1. Apply the fundamental concepts of Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) in electronic systems. 2. Illustrate the coupling mechanisms and their impact on system performance. 3. Apply mitigation techniques to control EMI issues. 4. Employ EMC guidelines for PCB design. 5. Illustrate the various Measurement Techniques in EMC. 6. Analyze the EMC standards for diverse applications.					
Module 1	EMI/EMC Concepts	4 Hours			
EMI/EMC definitions – Units - Sources of EMI: Classification, Lightning, ESD, NEMP - Conducted and radiated emission - Conducted and radiated susceptibility – Intra and inter system EMI - In band interference - Spectrum conservation - Radiation hazard - Specific Absorption Rate (SAR).					
Module 2	EMI Coupling Principles	4 Hours			
Conductive coupling: Common-mode, Differential-mode - Inductive coupling - Capacitive coupling - Radiative coupling					
Module 3	EMI Control Techniques -I	8 Hours			
Grounding: Earthing principle, Types of Grounding- system grounding - Shielding: Shielding theory and shielding effectiveness, Shielding integrity at discontinuities, Conductive coatings, Cable shielding, Bonding: Shape and material for bond strap- general guidelines for good bonds.					
Module 4	EMI Control Techniques -II	8 Hours			
EMI Filters: Characteristics of filters, Impedance mismatch effects, Lumped element filters, Power line filter design, Common mode filter, Differential mode filter - EMI suppression devices and components: EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, Transient and surge suppression devices.					
Module 5	EMC Design of PCBs	8 Hours			
RF Sources in PCB - SMD / through hole components, Pins, Basic loops, Differential vs Common mode - Board layout: Ground plane and Power plane, ground bounce, Power distribution for two-layer boards, Power supply decoupling, Board zoning, Signal traces, Cross talk, Trace routing - Cables and connectors.					
Module 6	EMI Measurements	5 Hours			
Radiated interference measurements: Open area test site measurement, anechoic chamber, TEM cell; Reverberating chamber - Conducted interference measurements: Characterization of conduction currents voltages, Conducted EM noise on power supply lines, Conducted EMI from equipment - Pulsed interference immunity: ESD/EFT, Electrical surge - Time domain EMI measurement					
Module 7	EMC Standards	4 Hours			
Military standards, IEEE/ ANSI Standards, CISPR/IEC, FCC standards, European Standards, VDE Standards, Other EMC Standards, Company Standards, EMC compliance for wireless devices, Radio Equipment Directive (RED).					
Module 8	Contemporary Issues	2 Hours			
	Total Lecture Hours	45 Hours			
Text Books:					

1.	Clayton R.Paul, “Introduction to Electromagnetic Compatibility”, Wiley-Interscience, 2022
Reference Books:	
1.	Henry W.Ott., “Electromagnetic Compatibility Engineering”, Wiley, 2009.
2.	V.P.Kodali, “Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models”, Wiley-IEEE Press, 2001
3.	Christos Christopoulos, “Principles and Techniques of Electromagnetic Compatibility”, CRC Press, 2007.
4.	Mark I. Montrose, “EMC Made Simple Printed Circuit Board and System Design”, Montrose Compliance Services, 2014.
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test	
Recommended by Board of Studies	28-02-2023
Approved by Academic Council	No. 69 Date 16-03-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Apply the fundamental concepts of Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) in electronic systems.	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-
CO2	Illustrate the coupling mechanisms and their impact on system performance.	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-
CO3	Apply mitigation techniques to control EMI issues.	3	-	-	-	-	2	-	-	-	-	-	-	2	2	-
CO4	Employ EMC guidelines for PCB design.	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-
CO5	Illustrate the various Measurement Techniques in EMC.	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-
CO6	Analyze the EMC standards for diverse applications.	-	3	-	-	-	-	-	-	-	-	-	-	2	2	-

Course Code	Course Title	L	T	P	C
BECE315L	Optical Networks	3	0	0	3
Pre-requisite	BECE318L, BECE318P	Syllabus version			
		1.0			
Course Objectives					
1. To introduce Optical Components, Transmission system Engineering and Optical Digital Networks.					
2. To design Optical WDM Networks and to understand the routing techniques.					
3. To elucidate about Optical packet switching, OTN and access networks.					
4. To analyze the various optical network performances and to understand traffic management, fault management and security.					
Course Outcomes					
At the end of the course, students will be able to					
1. Use the principles of optical components and the transmission system engineering to develop optical networks.					
2. Demonstrate the various network architectures used in optical digital networks.					
3. Apply the WDM network design principles to develop wavelength routing networks.					
4. Apply the principles of packet switching, access networks and OTN technology for high-speed optical networks.					
5. Analyze optical channel performance for effective routing and congestion control in optical networks.					
6. Employ network security, protection and fault management in optical networks.					
Module:1	Optical system components	6 hours			
Optical System Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters; Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, Overall design considerations.					
Module:2	Optical digital networks	6 hours			
Introduction to Optical Networks; SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks – Topologies, Media-Access Control Protocols and Testbeds; Wavelength Routing Architecture.					
Module:3	Wavelength routing networks	6 hours			
WDM Network Design - Cost tradeoffs, Virtual Topology Design, Routing and wavelength assignment, Statistical Dimensioning Models.					
Module:4	Packet switching and access networks	6 hours			
Photonic Packet Switching – OTDM, Multiplexing and De-multiplexing, Synchronization, Header Processing, Buffering, Burst Switching, Testbeds; Access Networks.					
Module:5	Optical transport network and network synchronization	6 hours			
Introduction- OTN Network Layers - FEC in OTN- OTN Frame Structure- OTN and DWDM- OTN Management- Synchronization - The Timing Signal- Signal Quality- Transmission Factor- Jitter and Wander- Photodetector Responsivity and Noise Contributors.					
Module:6	Network performance	8 hours			
Introduction-Channel Performance- Power-Bandwidth Ratio- Shannon's Limit - Optical Signal to Noise Ratio - Factors That Affect Channel Performance - Analysis of BER and SNR Related to Channel Performance - BER and SNR. Traffic Management and Control-Client Bandwidth Management - Wavelength Management – Paths with --Congestion Management - Routing Discovery of Optical Network -Node and Network - Wavelength Management Strategies.					
Module:7	Network protection, fault management and Security	5 hours			

Introduction- Fault Detection and Isolation - Fault and Service Protection - Point-to- Point Networks- Mesh Network Protection -Ring-Network - Ring-to-Ring Protection - Multi-ring Shared Protection - Network Security Issues - Definitions -Security - Security Layers in Communication Networks.			
Module:8		Contemporary Issues	
		Total Lecture hours:	
		2 hours	
		45 hours	
Text Book(s)			
1.	Debasish Datta, “Optical Networks”, OUP Oxford (2021), 1 st Edition.		
Reference Books			
1.	Biswanath Mukherjee, "Optical WDM Networks", Springer, 2006. 1 st Edition.		
2.	Stamatios V. Kartalopoulos "Next Generation Intelligent Optical Networks” Springer Science Business Media. LLC, 2008, 1 st Edition.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-02-2023	
Approved by Academic Council		No.69	Date 16-03-2023

[illegible]

Course Code	Course Title	L	T	P	C
BECE316E	Digital Image Processing	3	0	2	4
Pre-requisite	BECE301L, BECE301P	Syllabus version			
		1.0			
Course Objectives					
<					

Module:7	Representation and Description	5 hours
Boundary descriptors - Region descriptors - Texture descriptors - Use of Principal Components for Description.		
Module:8	Contemporary Issues	2 hours
	Total Lecture hours:	45 hours
Text Book(s)		
1.	Rafael C.Gonzalez & Richard E.Woods, “Digital Image Processing”, 2017, 4 th edition, Pearson Education, USA	
Reference Books		
1.	Anil K.Jain, “Fundamentals of Digital Image Processing”, 2015, 1 st edition, Pearson India, India	
2.	Mark Nixon & Alberto Aguado, “Feature Extraction, and Image Processing”, 2012, 3 rd edition, Elsevier’s Science & Technology Publications, Woborn MA, Great Britain.	
3.	Scott E Umbaugh, “Digital Image Processing and Analysis: Human and Computer Vision Applications with CVIP tools”, 2011, 2 nd edition, CRC press, Boca Raton, FL, USA.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Indicative Experiments		
1	(a) Perform point to point operation on the given image and compute the following and interpret changes in image i. Image Negative ii. Power law transformation iii. Log transformation (b) Perform contrast stretching for the given poor contrast image. (c) Perform histogram equalization for the given image and analyze the enhanced quality of the image.	3 hours
2	a) Read the input Image and perform Interpolation and Decimation. Show the effect of image shrinking and zooming. b) Read the input image and show the effect of gray level slicing for different levels. c) Perform Bitplane slicing for given image and comment on the number of visually significant bit planes in each image.	3 hours
3	Implement the following spatial domain filtering techniques for an image a) Low Pass Filtering b) High Pass Filtering c) Order Statistics (Median) Filtering	3 hours
4	Perform DFT for the given image and obtain its Fourier spectrum. Compute IDFT. Verify the symmetric property of DFT and compare the result with Discrete Cosine Transform (DCT).	3 hours
5	Removal of fine details in an image by frequency domain filtering and analysis of information loss.	3 hours
6	Perform image enhancement, feature extraction studies and compression using DCT.	3 hours

7	a) Perform image enhancement, feature extraction studies and compression using DWT. b) Perform DWT of an image, analyze and further reconstruct the image using IDWT	3 hours
8	Segment the region of interest from a given image using region- based segmentation and watershed algorithm.	3 hours
9	Identifying objects in an image based on their boundaries.	3 hours
10	To detect moving objects in given image frames using background subtraction algorithm.	3 hours
Total Laboratory Hours		30 hours
Mode of assessment: Continuous assessment and FAT		
Recommended by Board of Studies		28-02-2023
Approved by Academic Council		No. 69 Date 16-03-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	Apply fundamental steps of image processing to enhance and analyze digital images.	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 2	Use two-dimensional transforms for digital image processing and analysis.	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 3	Analyze the effectiveness of various frequency domain filtering techniques for digital image enhancement.	-	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 4	Analyze color image processing techniques across different color models for image enhancement.	-	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 5	Employ image compression techniques to achieve efficient image compression.	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 6	Illustrate various image segmentation techniques and descriptor methods to categorize and analyze image regions effectively.	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 7	Analyze image-processing algorithms using simulation tools for different applications.	-	3	-	-	3	-	-	-	2	2	-	-	-	2	-

Course Code	Course Title	L	T	P	C
BECE320E	Embedded C Programming	2	0	2	3
Pre-requisite	NIL	Syllabus version			
		V 1.0			
Course Objectives					
1. To impart logical thinking and fundamental problem-solving skills via the use of a programming language. 2. To develop basic and advanced programming concepts using C and Embedded C language. 3. To interface with microcontroller using Embedded C language.					
Course Outcome					
At the end of the course, students will be able to					
1. Apply the C programming concepts to handle various data types and decision-making applications. 2. Utilize derived data types, pointers, and user-defined functions in C programming. 3. Employ 8051 microcontroller architecture concepts to develop embedded applications. 4. Apply embedded C programming techniques for interrupts handling and peripherals interfacing in the 8051 microcontrollers. 5. Analyze embedded C programs for designing microcontroller-based applications with I/O interfacing.					
Module:1	Introduction to C	3 hours			
Introduction to Embedded C, difference between C and Embedded C. Introduction to C programming, comments, identifiers, variables, headers, data types, operators, order of operations, format specifies, escape sequence characters, input and output statements, programs on sequential statements.					
Module:2	Control and loop statements	4 hours			
Control statements: if, if-else, if-else ladder, elseif ladder, switch. Loops: do-while, while, for loops and nested loops. Break, continue, goto and exit statements. Programs on if, switch and loops.					
Module:3	Arrays and strings	3 hours			
Arrays: one dimensional and multi-dimensional array, programs on arrays. Strings, functions, pointers.					
Module:4	Introduction to 8051 microcontrollers	6 hours			
Introduction to microcontroller, difference between microcontroller and microprocessor, 8051: architecture, pin diagram of 8051, memory organization, special function registers, I/O pins, timers, interrupts, serial interface, power consumption, external interface of the standard 8051.					
Module:5	8051 programming in C	4 hours			
Data types: sbit, sfr, and bit. Producing delay using loops, programming I/O ports: bit addressable and byte addressable programming, programs on sending and receiving data through I/O ports. Programs on logic operations, data conversion, data serialization with I/O ports.					
Module:6	Timer and serial port programming	4 hours			
Programs on accessing timers registers, programs on producing time delay using mode 1 and mode 2, programs on generating various clock frequencies, programming of timers 0 and 1 as counters. Serial port programming: transmitting and receiving data with different baud rates. Programs on timer and Serial communication interrupt.					
Module:7	Interfacing with displays and sensors	4 hours			
Programming of keyboard interfacing, programming of LEDs interfacing, programming of seven segment display interfacing, interfacing circuit description and programming of 16 x 2 LCD, ADC, DAC and temperature sensor interfacing.					
Module:8	Contemporary issues	2 hours			
	Total Lecture hours:	30 hours			
Text Book(s)					

1	Mike McGrath, C Programming in easy steps, 2019, 4th Edition, In Easy Steps Limited.
2	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, 2014, The 8051 Microcontrollers & Embedded Systems, 2nd edition, Pearson.
Reference Books	
1.	Barrett, Michael, and Ambony Massa. Programming Embedded Systems, with C and GNU Development Tools, 2020, O'Reilly Media.
2	Herbert Schildt, C: The Complete Reference, 2017, 4th Edition, McGraw Hill Education.
Mode of evaluation: Internal Assessment (CAT, quizzes, Digital Assignments) & Final Assessment Test (FAT)	
Lab Component:	
Indicative Experiments	
1	Programs on Sequential statements 2 hours
2	Programs on Condition and Control statements 2 hours
3	Programs on Arrays 2 hours
4	Programs on Strings & Functions 2 hours
5	Programs on I/O ports 2 hours
6	Programs on Timer/Counter 4 hours
7	Programs on serial communication 2 hours
8	Programs on Timer Interrupts 2 hours
9	Programs on Serial Communication Interrupts 2 hours
10	Programs on External interrupts 2 hours
11	Programs on interfacing Keypad and LCDs 4 hours
12	Programs on interfacing ADC, DAC and Sensors 4 hours
Total Laboratory Hours 30 hours	
Mode of assessment: Continuous assessment and FAT	
Recommended by Board of Studies	
07-11-2023	
Approved by Academic Council	
No. 72	Date 13-12-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Apply the C programming concepts to handle various data types and decision-making applications.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO2	Utilize derived data types, pointers, and user-defined functions in C programming.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO3	Employ 8051 microcontroller architecture concepts to develop embedded applications.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO4	Apply embedded C programming techniques for interrupts handling and peripherals interfacing in the 8051 microcontrollers.	3	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO5	Analyze embedded C programs for designing microcontroller-based applications with I/O interfacing.	-	3	-	-	3	-	-	2	2	-	-	-	-	-	3

Course Code	Course Title	L	T	P	C
BECE403E	Embedded Systems Design	3	0	2	4
Pre-requisite	BECE204L, BECE204P	Syllabus version			
		1.0			
Course Objectives					
1. To acquaint students with definition, characteristics, challenges and design lifecycle of Embedded Systems by imparting the fundamental knowledge of I/O interfacing, serial communication protocols, wireless technologies, design using UML models 2. To familiarize the concepts and features of Real-time operating systems, task scheduling, and inter-task communication. 3. To impart various programming tools, modeling and simulation packages to program, design, simulate and build Embedded Systems					
Course Outcomes					
At the end of the course, students will be able to					
1. Analyze the functionalities for the given application and performance metrics to design an embedded system. 2. Apply appropriate selection criteria for microprocessors and peripheral to implement the embedded system. 3. Analyze the microcontroller programs to implement the system functions. 4. Analyze the specific perspective of the embedded application using different modelling languages. 5. Use various emerging protocols for embedded communication. 6. Apply RTOS for developing real-time systems.					
Module:1	Embedded System Product Development	4 hours			
Characteristics of embedded systems, Classification of embedded systems, Embedded product development cycle, Embedded System Design Challenges, Performance and Benchmarking Tools.					
Module:2	Embedded Hardware Design	5 hours			
Processor classification - general purpose, customized, application specific processors, Microcontroller architectures (RISC, CISC), Embedded Memory, Strategic selection of processor and memory, Power Supply Design Considerations for Embedded Systems.					
Module:3	Embedded Software Development Environment	6 hours			
Cross assemblers/compilers, Linker, Runtime Library, Pre-processor Workflow, make files, Compiler Tool chains – gcc & ARM, Device Driver, Firmware, Middleware - Debugging tools: Emulators, Simulators, In-Circuit Debuggers, Logic Analyzer, Integrated Development Environment (IDE).					
Module:4	Modeling Embedded Systems	6 hours			
Control data flow graph, Finite state machine model, Petrinet Model, Unified model language					
Module:5	Programming the Peripherals of Microcontrollers	6 hours			
Programming GPIO pins, Timers / Counters, Watchdog Timer, PWM generation, ADC, DAC, LED, switches, keypad, LCD.					
Module:6	Emerging Communication Protocols	8 hours			
UART, SPI, I2C, NFC, CAN, Bluetooth, Zigbee, Wi-Fi					
Module:7	Embedded Real –Time Operating Systems	8 hours			
Introduction to basic concepts of RTOS- Task, process & threads, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Schedulability Analysis, Inter process Communication, Performance Metrics of RTOS					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:				45 hours
Text Book(s)					

1.	Raj Kamal, “Embedded systems Architecture, Programming and Design”, 2017, Third Edition, McGraw Hill Education, India.		
Reference Books			
1.	Marilyn Wolf, “Computers as components: Principles of Embedded Computing System Design”, 2017, Fourth Edition, Morgan Kaufmann publications (Elsevier), United States.		
2.	Jiacun Wang, "Real-Time Embedded Systems", 2017, First Edition, Wiley Publishers, United States.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Indicative Experiments			
1.	Experiments based on interfacing I/O devices		4 hours
2.	Experiments based on monitoring and control using sensors and Actuators		6 hours
3.	Experiments based on wired Communications Protocols (UART, SPI, I2C, CAN)		8 hours
4.	Experiments based wireless Communications Protocols (Wi-Fi, Bluetooth)		6 hours
5.	Experiments based on RTOS		6 hours
Total Laboratory Hours			30 hours
Mode of assessment: Continuous assessment and FAT			
Recommended by Board of Studies		28-02-2023	
Approved by Academic Council		No. 69	Date 16-03-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Analyze the functionalities for the given application and performance metrics to design an embedded system.	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	Apply appropriate selection criteria for microprocessors and peripheral to implement the embedded system.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3	Analyze the microcontroller programs to implement the system functions.	-	3	-	-	3	-	-	-	-	-	-	-	-	-	3
CO4	Analyze the specific perspective of the embedded application using different modelling languages.	-	3	-	-	3	-	-	-	-	-	-	-	-	-	3
CO5	Use various emerging protocols for embedded communication.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO6	Apply RTOS for developing real-time systems.	3	-	-	-	3	-	-	2	2	-	-	-	-	-	3

Course Code	Course Title	L	T	P	C
BECE404L	Detection, Estimation and Modulation Theory	3	0	0	3
Pre-requisite	BECE207L	Syllabus version			
		1.0			
Course Objectives					
1. To familiarize the students a hypothesis testing for various signal detection models. 2. To make them understand and apply Gaussian detection scheme. 3. To make them proficient in scalar and vector parameter estimation. 4. To let them develop an expertise in Kalman filter based estimation.					
Course Outcomes					
At the end of the course, students will be able to					
1. Employ the classical detection techniques in signal processing applications. 2. Apply detection algorithms for gaussian processes. 3. Illustrate different classical techniques for scalar and vector parameter estimation. 4. Compute the parameter estimation techniques for Gaussian processes. 5. Analyze estimators for continuous time random processes. 6. Apply Kalman filter techniques for parameter estimation.					
Module:1	Classical Detection Theory	6 hours			
Introduction - Simple Binary Hypothesis Tests - Decision Criteria - Performance: Receiver Operating Characteristic - M Hypotheses - Performance Bounds and Approximations - Monte Carlo Simulation - Importance Sampling -Simulation of PF - Simulation of PM - Independent Observations - Simulation of the ROC, Examples, Iterative Importance Sampling.					
Module:2	Gaussian Detection	8 hours			
Real and Circular Complex Gaussian Random Vectors - General Gaussian Detection - Equal Covariance Matrices - Independent Components with Equal and Unequal Variances - Eigen decomposition - Optimum Signal Design - Interference Matrix: Estimator – Subtractor - Low-Rank Models - Equal Mean Vectors - Diagonal Covariance Matrix on H0: Equal Variance – Independent and Identically Distributed Signal Components - Independent Signal Components: Unequal Variances - Correlated Signal Components - Low-Rank Signal Model - Symmetric Hypotheses - Uncorrelated Noise - Nondiagonal Covariance Matrix on H0, H1, Signal on Both Hypotheses, M Hypotheses					
Module:3	Classical Parameter Estimation	6 hours			
Introduction - Scalar Parameter Estimation - Random Parameters: Bayes Estimation Nonrandom Parameter Estimation - Bayesian Bounds - Lower Bound on the MSE Asymptotic Behavior - Exponential Family - Nonrandom Parameters - Random Parameters - Summary of Scalar Parameter Estimation					
Module:4	Multiple Parameter Estimation	5 hours			
Multiple Parameter Estimation - Estimation Procedures - Random Parameters - Nonrandom Parameters - Measures of Error- Nonrandom Parameters - Random Parameters - Bounds on Estimation Error - Nonrandom Parameters - Random Parameters - Hybrid Parameters - Hybrid Parameters - Joint ML and MAP Estimation					
Module:5	Gaussian Estimation	7 hours			
Introduction - Nonrandom Parameters - General Gaussian Estimation Model - Maximum Likelihood Estimation - Crammer–Rao Bound - Fisher Linear Gaussian Model - White Noise - Low-Rank Interference - Separable Models for Mean Parameters - Covariance Matrix Parameters - White Noise - Colored Noise - Rank One Signal Matrix Plus White Noise - Rank One Signal Matrix Plus Colored Noise - Linear Gaussian Mean and Covariance Matrix Parameters - White Noise					
Module:6	Estimation of Continuous-Time Random Processes	5 hours			

Course Code	Course Title	L	T	P	C
BECE405L	Cognitive Radio Networks	3	0	0	3
Pre-requisite	BECE317L, BECE317P	Syllabus version			
		1.0			
Course Objectives					
1. To understand the principles and importance of cognitive radio in the context of next-generation networks 2. To analyze various spectrum sensing, access and management protocols 3. To introduce the challenges and opportunities associated with cognitive radio networks					
Course Outcomes					
At the end of the course, the student will be able to					
1. Illustrate the architecture cognitive radio and software defined radio. 2. Employ dynamic spectrum access and sharing techniques in cognitive radio. 3. Apply signal detection techniques in centralized and decentralized Cognitive Radio Networks 4. Analyze Medium Access Control and Network Layer protocol in CRNs. 5. Employ the standards and spectrum management in CRNs.					
Module:1	Introduction to Cognitive Radio	6 hours			
Evolution of Cognitive Radio, Cognitive Radio in 4G/5G Wireless Communications, Key Applications- Interoperability, Dynamic Spectrum Access, Regulatory Issues of Cognitive Access, Cognitive radio architecture, Introduction to software defined radio (SDR)-architecture and design principles, Reconfigurable wireless communication systems					
Module:2	Spectrum Access and Sharing	6 hours			
Unlicensed Spectrum Sharing, Licensed Spectrum Sharing, Secondary Spectrum Access, Non-Real-Time Spectrum Access and Sharing, Real-Time Spectrum Access and Sharing- Negotiated Access, Opportunistic Access, Overlay Approach, Underlay Approach					
Module:3	Spectrum Sensing and Management	8 hours			
Spectrum Sensing to Detect Specific Primary System-Conventional spectrum sensing, power control, Power-scaling power control, Cooperative spectrum sensing, Spectrum sensing procedure. Spectrum Sensing for Cognitive Multi-Radio Networks-Multiple system sensing, Radio resource sensing					
Module:4	Medium Access Control	7 hours			
MAC for cognitive radios, Multi-channel MAC-Collision avoidance/resolution, Access negotiation, Slotted-ALOHA with Rate-Distance Adaptability, CSMA with AMC-CSMA with spatial reuse transmissions, Cross layer power-rate control scheme					
Module:5	Network Layer Design	6 hours			
Routing in Mobile Ad Hoc Networks-Features of routing in cognitive radio networks (CRN), Dynamic source routing in MANET, Ad-hoc on-demand distance vector (AODV), Routing in CRN-Routing of dynamic and unidirectional cognitive radio links					
in CRN, Control of CRN-Flow control and end-to-end error control, Network tomography, Self-Organized CRNs.					
Module:6	Trusted Cognitive Radio Networks	6 hours			
Framework of Trust in CRN, Trusted Association and Routing, Trust with Learning- Modified Bayesian learning, Learning experiments for CRN, Security in CRN- Dilemma of CRN security, Requirements and challenges for preserving user privacy in CRNs, Implementation of CRN security.					

Course Code	Course Title	L	T	P	C
BECE406E	FPGA Based System Design	2	0	2	3
Pre-requisite	BECE102L, BECE102P	Syllabus version			
		1.0			
Course Objectives					
1. Understand FPGA Architecture and technologies 2. Modeling of complex digital sub-systems 3. Implementation of complex FPGA applications in real world scenario					
Course Outcomes					
At the end of the course, students will be able to					
1. Construct Boolean functions using programmable logic devices 2. Model various abstraction levels using Verilog HDL 3. Implement data path and clock path circuits using Verilog HDL 4. Apply synthesis and timing constraints for digital circuits 5. Illustrate the concept of SoC design flow 6. Employ FPGA based system design for signal processing applications 7. Analyse reconfigurable system performance for various applications using FPGA					
Module:1	Programmable Logic Devices	4 hours			
Types of Programmable Logic Devices: PLA, PAL, CPLD - FPGA Architecture – Programming Technologies-Chip I/O- Programmable Logic Blocks- Fabric and Architecture of FPGA.					
Module:2	HDL Fundamentals	3 hours			
Verilog Behavioral, Data Flow and Structural Modeling, Useful Modeling Techniques.					
Module:3	Implementation of Arithmetic system	5 hours			
Arithmetic Circuits: High Speed Adders, Carry look-ahead adder, Carry save adders, Conditional Sum adders, Sequential and Parallel Multipliers					
Module:4	FSM and memory modelling	5 hours			
Synchronous and Asynchronous FIFO – Single port and Dual port ROM and RAM - FSM Verilog modeling of Sequence detector - Serial adder - Vending machine.					
Module:5	Synthesis and Timing Analysis	3 hours			
Synthesis, Optimization of Speed: Introduction, Strategies for Timing Improvement; Optimization of Area, Optimization of power					
Module:6	SoC Design	4 hours			
Introduction to hardware – software codesigns, Introduction to Qsys and Intel Quartus prime tool, Nios II Software Build Tools for Eclipse, Incorporate custom peripherals & instructions into an embedded system.					
Module:7	FPGA Applications	4 hours			
Embedded system design using FPGAs, DSP using FPGAs, Dynamic architecture using FPGAs, reconfigurable systems, application case studies. Simulation / implementation exercises of combinational, sequential and DSP kernels on Xilinx / Altera boards.					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:	30 hours			
Text Book(s)					
1.	Michael D Ciletti, Advanced Digital Design with the Verilog HDL, Prentice Hall, Second Edition, 2017.				
Reference Books					

1.	Charles H Roth Jr, Lizy Kurian John and ByeongKil Lee Digital Systems Design using Verilog, Cengage Learning, First Edition, 2016.		
2.	Wayne Wolf, FPGA Based System Design, Prentices Hall Modern Semiconductor Design Series, 2011.		
3.	Ming-Bo Lin, Digital Systems Design and Practice: Using Verilog HDL and FPGAs, Create Space Independent Publishing Platform, Second Edition, 2015.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Indicative Experiments			
1.	Design of adders and Multipliers		6 hours
2.	Design of FSM		6 hours
3.	Design of Memory circuits		6 hours
4.	Synthesis and Timing Analysis		6 hours
5.	System design using Qsys		6 hours
Total Laboratory Hours			30 hours
Mode of assessment: Continuous assessment and FAT			
Recommended by Board of Studies		28-02-2023	
Approved by Academic Council		No. 69	Date 16-03-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Construct Boolean functions using programmable logic devices	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	Model various abstraction levels using Verilog HDL	3	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO3	Implement data path and clock path circuits using Verilog HDL	3	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO4	Apply synthesis and timing constraints for digital circuits	3	-	-	-	2	-	-	-	-	-	-	-	-	-	3
CO5	Illustrate the concept of SoC design flow	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO6	Employ FPGA based system design for signal processing applications	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO7	Analyse reconfigurable system performance for various applications using FPGA	-	3	-	-	3	-	-	-	2	2	-	-	-	-	3

Course Code	Course Title	L	T	P	C
BECE407E	ASIC Design	2	0	2	3
Pre-requisite	BECE303L, BECE303P	Syllabus version			
	`	1.0			
Course Objectives					
1. Explain the HDL coding guidelines, synthesizable HDL constructs and RTL synthesis Flow with respect to different cost functions. 2. Teach how to perform Static Timing Analysis for ASIC design. 3. Discuss the guidelines at each abstraction level in physical design 4. Provide detailed insight on importance of physical design verification					
Course Outcomes					
At the end of the course, students will be able to					
1. Illustrate the stages and processes involved in ASIC design methodology. 2. Employ the guidelines for RTL synthesis to develop efficient and reliable digital systems. 3. Apply basic timing constraints to perform static timing analysis of digital circuits. 4. Apply On-Chip Verification (OCV) and time borrowing techniques in advanced static timing analysis. 5. Illustrate physical design and verification guidelines for ASIC design process. 6. Analyze ASIC based system design using EDA tools.					
Module:1	ASIC Design Methodology & Design Flow	3 hours			
Implementation Strategies for Digital ICs: Custom IC Design- Cell-based Design Methodology - Array based implementation approaches - Traditional and Physical Compiler based ASIC Flow.					
Module:2	Verilog HDL Coding Style for Synthesis	6 hours			
HDL Coding style – Guidelines and Recommendation - FSM Coding Guideline and Coding Style for Synthesis. Datapath and Control Logic Design.					
Module:3	RTL Synthesis	3 hours			
RTL synthesis Flow – Synthesis Design Environment & Constraints – Architecture of Logic Synthesizer - Technology Library Basics– Components of Technology Library –Synthesis Optimization- Technology independent and Technology dependent synthesis- Data path Synthesis – Low Power Synthesis - Formal Verification.					
Module:4	Basic Timing Analysis	4 hours			
Timing Parameter Definition – Setup Timing Check- Hold Timing Check- Multicycle Paths- Half-Cycle Paths- False Paths					
Module:5	Advanced Timing Analysis	5 hours			
Clock skew optimization – On-Chip Variations- AOCV-Time Borrowing- Setup and Hold Violation Fixing.					
Module:6	Physical Design	5 hours			
Detailed steps in Physical Design Flow- Guidelines for Floor plan, Placement, CTS and routing– ECO flow – Signal Integrity Issues.					
Module:7	Physical Design Verification	3 hours			
Timing Sign-off, Physical Verification – Signoff DRC and LVS, ERC, IR Drop Analysis, Electro-Migration Analysis and ESD Analysis.					
Module:8	Contemporary Issues	1 hours			
	Total Lecture hours:	30 hours			

Text Book(s)			
1.	Vaibbhav Taraate, ASIC Design and Synthesis RTL Design Using Verilog, Springer, First Edition, 2021, Singapore.		
Reference Books			
1.	Khosrow Golshan, PHYSICAL DESIGN ESSENTIALS An ASIC Design Implementation Perspective, First Edition, 2010.		
2.	Michael John Sebastian Smith, Application-Specific Integrated Circuits, First Edition, 2002.		
3.	J. Bhasker and Rakesh Chadha, Static Timing Analysis for Nanometer Designs, Springer, First Edition, 2010, USA.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Indicative Experiments			
1.	Design of Digital Architecture for given specification		6 hours
2.	Logical Synthesis of Digital Architecture		6 hours
3.	Netlist Optimization and Formal Verification		6 hours
4.	Physical Synthesis of Digital Architecture		6 hours
5.	Physical Verification of digital architecture		6 hours
Total Laboratory Hours			30 hours
Mode of assessment: Continuous assessment and FAT			
Recommended by Board of Studies		28-02-2023	
Approved by Academic Council		No. 69	Date 16-03-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Illustrate the stages and processes involved in ASIC design methodology.	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	Employ the guidelines for RTL synthesis to develop efficient and reliable digital systems.	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	Apply basic timing constraints to perform static timing analysis of digital circuits.	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO4	Apply On-Chip Verification and time borrowing techniques in advanced static timing analysis.	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	Illustrate physical design and verification guidelines for ASIC design process.	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO6	Analyze ASIC based system design using EDA tools.	-	3	-	-	3	-	-	-	2	2	-	-	3	-	-

Course Code	Course Title	L	T	P	C
BECE408L	Microwave Integrated Circuits	3	0	0	3
Pre-requisite	BECE305L, BECE305P	Syllabus version			
		1.0			
Course Objectives					
1. To have the essential knowledge of various planar microstrip circuits 2. To design and analyse various types of microwave planar circuits 3. To acquaint the fabrication techniques and tolerances for MIC circuits					
Course Outcomes					
At the end of the course, the student will be able to:					
1. Determine the characteristics of different planar transmission lines. 2. Compute L and C for lumped elements and microstrip circuits. 3. Illustrate the resonant characteristics of microstrip resonators. 4. Analyze performance of microstrip filters. 5. Analyze performance of microwave amplifiers, oscillators and mixers. 6. Employ various fabrication techniques for planar microwave circuits.					
Module:1	Planar transmission lines	6 hours			
Introduction, types of MICs and their technology; Microstrip lines, strip lines, slotted lines, co-planar waveguides, coupled lines and SIW. Losses in microstrip transmission lines.					
Module:2	Passive elements for MICs and discontinuities	8 hours			
Lumped microstrip components: Design of microstrip and chip inductors, capacitors, resistors, Quasi lumped microstrip elements: Open and short-circuited stubs (quarter wavelength, half wavelength). Interdigital capacitors, Approximate analysis. Discontinuities: Corners, symmetrical step, T-junction and series gaps					
Module:3	Microstrip Resonators	6 hours			
Analysis and Design of Quarter & Half wave length resonators, Ring resonators, Patch resonators and Slot resonators.					
Module:4	Microwave Filter Design	7 hours			
Introduction, Band pass filter: Insertion loss method, Conversion from low pass to band pass, Design of band pass filter using lumped elements, distributed elements, impedance inverters and coupled line filters.					
Module:5	Microwave Amplifiers	6 hours			
Single stage amplifier design for maximum and specific gain, Noise figure, Design of low noise amplifiers, Gain compression, Intermodulation distortion, third order intercept point, dynamic range.					
Module:6	Microwave Oscillators and Mixers	5 hours			
Conditions for oscillations, one port oscillator, two port oscillator (Transistor oscillators), Characteristics of mixer, Single ended diode mixer, Single ended FET mixer and Image reject mixer.					
Module:7	MIC and MMIC Fabrication Technologies	5 hours			
Hybrid MICs, Configuration, Dielectric substances, thick and thin film technology, LTCC, HTCC, Printed Circuit Board (PCB) Technology, Fabrication process of MMIC					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:	45 hours			
Text Book(s)					
1.	TC Edwards, MB Steer, Foundations for Microstrip circuit design, 4e, 2016, John Wiley, UK				

Course Code	Course Title	L	T	P	C
BECE409E	Sensors Technology	2	0	2	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To attain a broad familiarity with the principle of sensing and different sensors for real world applications 2. Study the various sensor technologies for the measurement of physical quantities and develop suitable signal conditioning circuits. 3. Identify most suitable sensors for each measurement application and get acquainted with fabrication and interfacing process					
Course Outcomes					
At the end of the course, the student will be able to:					
1. Determine sensors based on materials and sensing technologies. 2. Illustrate the operating principles of resistive, inductive, capacitive and self-generating sensors. 3. Compute R, L and C parameters required for signal conditioning circuits 4. Apply the processes involved in sensor fabrication. 5. Use the operating mechanisms of advanced and smart sensors for real-world applications. 6. Employ appropriate sensor for diverse use cases 7. Illustrate the performance characteristics of various integrated sensors for different applications.					
Module:1	Sensing Mechanism	4 hours			
Principles of Sensing: Resistive, Capacitive, Magnetic, Inductive, Piezoelectric, Piezo-resistance, Pyro-electric, Hall effect, RF sensing. Sensor materials and material properties. Sensor Technologies: Micro Technology, Micro-Electro- Mechanical Systems Technology, Nanotechnology. Example of Smart Sensors in Nature (Vision, Hearing, Touch, and Smell).					
Module:2	RLC and Self Generating Sensors	4 hours			
Resistive Sensors – Strain Gauges, Resistance Temperature Detectors, Thermistors, Light dependent resistors, Self and Mutual Inductive Transducers, LVDT, Capacitive Transducers, Variable Distance, Variable Area, Variable Dielectric Type Capacitive Sensors. Self-Generating Sensors – Thermoelectric Sensors, Piezoelectric Sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical Sensors.					
Module:3	Sensor Signal Conditioning	4 hours			
DC Bridges for Resistance Measurements-Wheatstone Bridge, Kelvin Bridge. AC Bridges for Capacitance and Inductance Measurements-AC Bridge, Schering Bridge. Sensor Compensation Circuits-Temperature, Non-linearity and Offset Compensation.					
Module:4	Sensor Fabrication	4 hours			
Thick and Thin Film Sensor Fabrication – Screen Printing Technology, PVD, CVD, Fabrication of MEMS and NEMS Sensors – Lithography, Micromachining Techniques					
Module:5	Advanced Sensors	4 hours			
Position Encoders, Resonant Sensors, Sensors Based on Semiconductor Junctions, Fiber-Optic Sensors, Ultrasonic-Based Sensors, Biosensors, Superconducting Quantum Interference Devices (SQUIDs).					
Module:6	Smart Sensors	4 hours			
Smart Transducers: Smart Sensors, Components of Smart Sensors, General Architecture of Smart Sensors, Evolution of Smart Sensors, Advantages, Application area of Smart Sensors.					
Module:7	Sensors for IoT	4 hours			
Sensor-Cloud; Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring					

Module:8	Contemporary Issues	2 hours
	Total Lecture hours:	30 hours
Text Book(s)		
1.	Winncy Y. Du, “Resistive, Capacitive, Inductive, and Magnetic Sensor Technologies”, 2019, 1 st Edition, CRC press, London.	
2.	B. C. Nakra and K. K. Chaudhary, “Instrumentation, Measurement and Analysis”, 2016, 4 th Edition, McGraw Hill Education India Private Limited.	
Reference Books		
1.	A.K. Sawhney, “A Course in Electronic Measurements and Instrumentation”, 2015, Dhanpat Rai & Co. (P) Limited.	
2.	Ramón Pallás-Areny and John G. Webster, “Sensors and Signal Conditioning” 2012, 2 nd Edition, John Wiley and Sons, Inc.	
3.	Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.	
4.	Nihtianov, Stoyan, and Antonio Luque, eds. Smart sensors and MEMS: Intelligent sensing devices and microsystems for industrial applications. Woodhead Publishing, 2018.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
List of Experiments		
1	Characteristics of Thermistor	2 hours
2	Characteristics of Strain Gauge	2 hours
3	Characteristics of Light Dependent Resistor	2 hours
4	Characteristics of Resistance Temperature Detector	2 hours
5	Characteristics of Angular potentiometer transducer model.	2 hours
6	Characteristics of LVDT	2 hours
7	Characteristics of Capacitive Level Sensor	2 hours
8	Characteristics of Thermocouples	2 hours
9	Characteristics of Photoelectric Tachometer	2 hours
10	Calibration of RTD and signal conditioning of RTD	2 hours
11	Calibration of Thermistor and signal conditioning of thermistor	2 hours
12	Characteristics of piezoelectric and Hall effect sensors	2 hours
13	Simulation of Biosensors/Chemical Sensors	2 hours
14	Simulation and design of sensors using MATLAB/LABVIEW/COMSOL	2 hours
15	PC based Data acquisition system.	2 hours
Total Laboratory Hours		30 hours
Mode of assessment: Continuous assessment & Final Assessment Test (FAT)		
Recommended by Board of Studies		28-02-2023
Approved by Academic Council		No. 69 Date 16-03-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Determine sensors based on materials and sensing technologies.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	Illustrate the operating principles of resistive, inductive, capacitive and self-generating sensors.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO3	Compute R, L and C parameters required for signal conditioning circuits	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO4	Apply the processes involved in sensor fabrication.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO5	Use the operating mechanisms of advanced and smart sensors for real-world applications.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO6	Employ appropriate sensor for diverse use cases	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO7	Illustrate the performance characteristics of various integrated sensors for different applications.	3	-	-	-	3	-	-	-	2	2	-	-	-	-	3

Course Code	Course Title	L	T	P	C
BECE410L	Micro-Electromechanical Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The course is aimed to					
1. Introduce MEMS technology and their application as Sensors and actuators.					
2. Comprehending various materials used in MEMS devices and also Micro-Nano fabrication techniques involved.					
Course Outcomes					
At the end of the course, students will be able to					
1. Illustrate MEMS applications and their scaling effects.					
2. Employ properties of MEMS materials for specific device applications.					
3. Implement appropriate fabrication techniques for MEMS applications.					
4. Apply sensing and actuation mechanisms used in MEMS.					
5. Analyze various actuating mechanisms and applications based on the same					
6. Compute the sensor response in diverse Bio-MEMS applications.					
7. Classify various sensors used in flexible and wearable MEMS applications					
Module: 1	Micro-electro Mechanical Systems (MEMS)	5 hours			
Historical background and evolution of Micro Electro Mechanical Systems (MEMS); Market for MEMS sensors -Real-world sensor/actuator examples; MEMS sensors in automobiles, smartphones, and Bio-medical applications. Scaling in MEMS - Scaling of length, surface area, and volume — Scaling and surface tension -Scaling in optics - Scaling in the electrostatic and electromagnetic domain, Thermal domain - Scaling in microfluidics.					
Module: 2	MEMS Materials and Properties	6 hours			
Crystal, Substrates and wafers, Silicon and Silicon compounds - Silicon oxide and nitride; Single Crystal Silicon growth (CZ and FZ methods); Thin metal films (Cr, Au, Ti, Pt) — Polymers (SU8, PMMA, PDMS); Glass and Quartz; Paper; Nanoparticles – CNTs – Graphene - MoS2; Choice and role of these substrates and materials in realizing miniature sensors. Important material properties- Young modulus - Poisson’s ratio - Density - Piezoresistive coefficients - Piezoelectric coefficients- TCR - Thermal conductivity - Material structure.					
Module: 3	MEMS Fabrication Technology	7 hours			
Silicon Wafer Cleaning - Oxidation - PVD (Thermal and E-beam evaporation, sputtering) - CVD - Lithography - Bulk- and surface-micromachining - LIGA - Bonding, and Packaging. Surface Modification Techniques for Polymers, Soft-Lithography; Micro molding; Replica molding, and Micro contact printing. Patterning Processes for flexible sensors - Printing technology, Non-Contact Type- Jet printing, Contact type - Screen printing, Gravure printing.					
Module:4	Sensing Mechanisms and MEMS Sensors	7 hours			
Sensing mechanisms – Capacitive, Piezoelectric, Piezoresistive, Electromagnetic, Optical, and Resonant sensing principles MEMS Sensors: Pressure sensors, Accelerometers, Gas sensors, Flow sensors, Gyroscopes, Microcantilevers as sensors, Imaging and displays, and Fiber-optic communication devices.					
Module:5	Actuation Mechanisms and MEMS Actuators	7 hours			
Actuation Mechanisms: Electrostatic, Piezoelectric, Electrothermal, Shape memory alloy (SMA) MEMS actuators: Microcantilever as actuators, Micro resonator, Microgripper, Micromirror, Micro motor, RF MEMS switch, Phase shifter, Varactor, and Micro heater.					
Module:6	BioMEMS	6 hours			

Glucose sensors, In Vitro and In Vivo diagnostics, μ -TAS - Micromixer, Micro Valve, Micro Pump, Drug delivery systems, and MEMS. Application models – Implantable Biochips – Micro needles – Microelectrodes - Neural prosthesis and catheter end sensors, Paper-based microfluidic devices as biosensors.					
Module:7		Flexible and Wearable Sensors		5 hours	
Textiles and polymers-based flexible sensors and applications – ECG, Blood Pressure, Epidermal Sensors, Tattoo based sensors, haptic gloves, strain sensors, pH sensors, and physiological sensors.					
Module:8		Contemporary Issues		2 hours	
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, 2017, 1st edition, Tata McGraw-Hill Publishing Company Ltd., India.				
Reference Books					
1.	Run-Wei Li, Gang Liu , Flexible and Stretchable Electronics Materials, Designs, and Devices – 2019, Taylor and Francis, Singapore				
2.	Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, 2018, CRC Press				
3	Chang Liu , Foundations of MEMS, 2016, Pearson India				
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz, and FAT					
Recommended by Board of Studies			28-02-2023		
Approved by Academic Council			No. 69	Date	16-03-2023

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Illustrate MEMS applications and their scaling effects.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	Employ properties of MEMS materials for specific device applications.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	Implement appropriate fabrication techniques for MEMS applications.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO4	Apply sensing and actuation mechanisms used in MEMS.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO5	Analyze various actuating mechanisms and applications based on the same	-	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO6	Compute the sensor response in diverse Bio-MEMS applications.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO7	Classify various sensors used in flexible and wearable MEMS applications	3	-	-	-	3	-	-	2	2	-	-	-	-	-	2

Course Code	Course Title	L	T	P	C
BECE411L	Cryptography and Network Security	3	0	0	3
Pre-requisite	BECE401L, BECE401P/ BCSE318L, BCSE318P	Syllabus Version			
		1.0			
Course Objectives					
1. To acquaint students with the basic concepts in need for security mechanism, classical and traditional Encryption techniques. 2. To impart knowledge to students regarding the significance of message confidentiality, Integrity and availability using Cryptography. 3. To acquaint the students to the different types of network & internet security and its significance.					
Course Outcomes					
At the end of the course, students will be able to 1. Apply the classical encryptions techniques in data communications. 2. Use the various mathematical principle to perform computations required in cryptographic techniques. 3. Analyze the symmetric and asymmetric ciphers in cryptosystem. 4. Apply hash functions and digital signature schemes for data integrity and authenticity. 5. Employ key management concepts and user authentication protocols in practical security scenarios. 6. Apply fundamental network security methods in practical scenarios.					
Module:1	Cryptography: Overview	4 hours			
Introduction, OSI Security Architecture, Security Attacks, Security Services and Mechanisms, Classical Encryption Techniques.					
Module:2	Mathematical Foundations	6 hours			
Number Theory and Finite Fields (Group, Ring and Fields), Fermat’s and Euler’s Theorems, The Chinese Remainder Theorem, Fast Exponentiation, Discrete Logarithms, Elliptic Curve Arithmetic, and Principles of Pseudorandom Number Generation.					
Module:3	Symmetric Ciphers	8 hours			
Modern Block Ciphers and Modern Stream Ciphers- DES, IDEA, AES, Pseudorandom Number Generation based on symmetric cipher, Key Exchange Algorithm: Diffie-Hellman Key Exchange.					
Module:4	Asymmetric Ciphers	7 hours			
RSA cryptosystem, ElGamal Cryptosystem, RABIN Cryptosystem, Elliptic Curve Cryptography simulating Elgamal, Pseudorandom Number Generation based on an asymmetric Cipher.					
Module:5	Data Integrity Algorithms	7 hours			
Cryptographic Hash Functions: MD4, SHA-512, Whirlpool, Message Authentication Codes, Digital Signatures: RSA, Elgamal, Schnorr, DSS.					
Module:6	Mutual Trust	5 hours			
Key Management and Distribution, X.509, User Authentication Protocols, Kerberos.					
Module:7	Network and Internet Security	6 hours			
Transport Layer Security, Wireless LAN Security, Electronic mail Security, Firewalls, IoT Threats.					
Module:8	Contemporary Issues	2 hours			

	Total Lecture hours:	45 hours
Text Book(s)		
1.	William Stallings, "Cryptography and Network security: Principles and Practice", 8th Edition, 2020, Pearson Education, India.	
Reference Books		
1.	Atul Kahate, “Cryptography and Network Security”, 4th Edition, 2019, The McGraw Hill Company.	
2	Behrouz A. Forouzan, Debdeep Mukhopadhyay “Cryptography & Network Security”, 3 rd edition, 2015, The McGraw Hill Company.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies		28-02-2023
Approved by Academic Council	No. 69	Date 16-03-2023

[illegible]

Course Code	Course Title		L	T	P	C
BECE391J	Technical Answers to Real Problems		0	0	6	3
Pre-requisite	NIL	Syllabus version				
		1.0				
Course Objectives						
1. To gain an understanding of real-life issues faced by society.						
2. To study appropriate technologies in order to find a solution to real life issues.						
3. Students will design system components intended to solve a real-life issue.						
Course Outcomes						
At the end of the course, students will be able to						
1. Determine real-life issues and requirements of society.						
2. Implement the technical solution using appropriate technologies to address the issues.						
3. Demonstrate the project through a technical report and presentation as a team member.						
Module Content			(Project Duration: Two Semesters)			
1. Students are expected to perform a survey and interact with society to find out the real-life issues.						
2. Logical steps with the application of appropriate technologies should be suggested to solve the identified issues.						
3. Subsequently the student should design the related system components or Processes which are intended to provide the solution to the identified real-life issues.						
General Guidelines:						
1. Identification of real-life problems						
2. Field visits can be arranged by the faculty concerned						
3. Maximum of 3 students can form a team (within the same/different discipline)						
4. Minimum of eight hours on self-managed team activity						
5. Appropriate scientific methodologies to be utilized to solve the identified issue						
6. Solution should be in the form of fabrication/coding/modelling/product design/process design/relevant scientific methodology(ies)						
7. Consolidated report to be submitted for assessment						
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component						
9. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility						
10. Contribution of each group member to be assessed						
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50– Report to be submitted, presentation and project reviews						
Recommended by Board of Studies			12-10-2022			
Approved by Academic Council			No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Determine real-life issues and requirements of society.	3	-	-	-	-	3	-	2	-	-	-	2	2	2	2
CO2	Implement the technical solution using appropriate technologies to address the issues.	3	2	-	2	3	-	-	2	-	-	-	2	2	2	2
CO3	Demonstrate the project through a technical report and presentation as a team member.		-	-	-	-	-	-	3	3	-	-	2	2	2	2

Course Code	Course Title	L	T	P	C
BECE392J	Design Project	0	0	6	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Students will be able to upgrade a prototype to a design prototype.					
2. Describe and demonstrate the techniques and skills necessary for the project.					
3. Acquire knowledge and better understanding of design systems.					
Course Outcomes					
At the end of the course, students will be able to					
1. Determine the design requirements and specifications to address societal needs.					
2. Design a working prototype using appropriate techniques and modern tools.					
3. Demonstrate the project, considering cost constraints, through a technical report and presentation as a team member.					
Module Content		(Project Duration: One Semester)			
Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Determine the design requirements and specifications to address societal needs.	3	2	-	-	-	3	-	2	-	-	-	-	2	2	2
CO2	Design a working prototype using appropriate techniques and modern tools.	-	-	3	-	3	-	-	-	-	-	-	2	2	2	2
CO3	Demonstrate the project, considering cost constraints, through a technical report and presentation as a team member.	-	-	-	-	-	-	-	-	3	3	3	-	2	2	2

Course Code	Course Title	L	T	P	C
BECE393J	Laboratory Project	0	0	6	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. The student will be able to conduct experiments on the concepts already learnt. 2. Analyse experimental data. 3. Present the results with appropriate interpretation.					
Course Outcomes					
At the end of the course, students will be able to 1. Devise a new laboratory experiment based on the course concepts. 2. Interpret the experimental data to verify the theoretical concepts. 3. Prepare technical reports on the experimental results and inferences.					
Module Content		(Project Duration: One Semester)			
Students are expected to perform experiments and gain hands-on experience on the theory courses they have already studied or registered in the ongoing semester. The theory course registered is not expected to have laboratory component and the student is expected to register with the same faculty who handled the theory course. This is mostly applicable to the elective courses. The nature of the laboratory experiments is depended on the course.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Devise a new laboratory experiment based on the course concepts.	3	-	-	-	-	-	-	-	-	-	-	2	2	2	2
CO2	Interpret the experimental data to verify the theoretical concepts.	3	-	-	-	2	-	-	-	-	-	-	2	2	2	2
CO3	Prepare technical reports on the experimental results and inferences.	-	-	-	-	-	-	-	-	-	3	-	-	2	2	2

Course Code	Course Title	L	T	P	C
BECE394J	Product Development Project	0	0	6	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Students will be able to translate a prototype to a useful product. 2. Apply relevant codes and standards during product development. 3. The student will be able to present his results by means of clear technical reports.					
Course Outcomes					
At the end of the course, students will be able to 1. Develop the prototype/working model as a viable product addressing societal needs. 2. Apply appropriate tools and standards, considering cost constraints, for product development. 3. Demonstrate the product through a technical report and presentation as a team member.					
Module Content		(Project Duration: Two Semesters)			
Students are expected to translate the developed prototypes / working models into a product which has application to society or industry.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Develop the prototype/working model as a viable product addressing societal needs.	-	-	3	2	-	3	-	-	-	3	-	2	2	2	2
CO2	Apply appropriate tools and standards, considering cost constraints, for product development.	-	-	-	-	3	-	-	3	-	-	3	2	2	2	2
CO3	Demonstrate the product through a technical report and presentation as a team member.	-	-	-	-	-	-	-	-	3	3	-	-	2	2	2

Course Code	Course Title	L	T	P	C
BECE395J	Computer Project	0	0	6	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Students will be able to analyse complex engineering processes.					
2. Describe the applications and limitations of a given engineering process.					
3. Present the results in written reports and oral presentations.					
Course Outcomes					
At the end of the course, students will be able to					
1. Use programming skills/modelling to simulate engineering processes/problems.					
2. Determine the feasibility and limitations of the given engineering problem.					
3. Prepare technical reports and presentations on the analysis and results.					
Module Content		(Project Duration: One Semester)			
Students are expected to use programming skills or modelling to analyse complex engineering processes. The student should be able to evaluate the application and limitations of the said engineering processes.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Use programming skills/modelling to simulate engineering processes/problems.	3	-	-	-	3	-	-	-	-	-	-	-	2	2	2
CO2	Determine the feasibility and limitations of the given engineering problem.	3	2	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	Prepare technical reports and presentations on the analysis and results.	-	-	-	-	-	-	-	-	3	3	-	-	2	2	2

Course Code	Course Title	L	T	P	C
BECE396J	Reading Course	0	0	6	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.					
2. Scrutinize technical literature and arrive at conclusions.					
3. Use insight and creativity for a better understanding of the domain of interest.					
Course Outcomes					
At the end of the course, students will be able to					
1. Apply relevant concepts from published literature/books to the domain of interest.					
2. Apply insights from the literature to arrive at conclusions on the domain of interest.					
3. Prepare a structured report presenting key insights from the literature.					
Module Content		(Project Duration: One Semester)			
This is oriented towards reading published literature or books related to niche areas or focused domains under the guidance of a faculty.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Apply relevant concepts from published literature/books to the domain of interest.	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO2	Apply insights from the literature to arrive at conclusions on the domain of interest.	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO3	Prepare a structured report presenting key insights from the literature.	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

Course Code	Course Title	L	T	P	C
BECE397J	Special Project	0	0	6	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Students will be able to identify and solve problems in a time-bound manner.					
2. Describe major approaches and findings in the area of interest.					
3. Present the results in a clear and concise manner.					
Course Outcomes					
At the end of the course, students will be able to					
1. Analyze an engineering problem using relevant information and approaches.					
2. Apply appropriate engineering tools and techniques to meet societal requirements.					
3. Present project outcomes in technical reports and research papers.					
Module Content		(Project Duration: Three Semesters)			
This is an open-ended course in which the student is expected to work on a time bound research project under the supervision of a faculty. The result may be a tangible output in terms of publication of research articles in a conference proceeding or in a peer-reviewed Scopus indexed journal.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Analyze an engineering problem using relevant information and approaches.	-	3	-	-	-	-	-	-	-	-	-	2	2	2	2
CO2	Apply appropriate engineering tools and techniques to meet societal requirements.	3	-	-	-	3	3	-	-	-	-	-	2	2	2	2
CO3	Present project outcomes in technical reports and research papers.	-	-	-	-	-	-	-	3	3	3	-	-	2	2	2

Course Code	Course Title	L	T	P	C
BECE398J	Simulation Project	0	0	6	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Students will be able to simulate a real system. 2. Identify the variables which affect the system. 3. Describe the performance of a real system.					
Course Outcomes					
At the end of the course, students will be able to 1. Analyze the functionality and performance of engineering systems using simulation models. 2. Develop solutions for complex engineering problems using simulation models. 3. Prepare project reports and research articles for publication.					
Module Content		(Project Duration: One Semester)			
The student is expected to simulate and critically analyse the working of a real system. Role of different variables which affect the system has to be studied extensively such that the impact of each step in the process is understood, thereby the performance of each step of the engineering process is evaluated.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Analyze the functionality and performance of engineering systems using simulation models.	-	3	-	-	3	-	-	-	-	-	-	2	2	2	2
CO2	Develop sustainable solutions for complex engineering problems using simulation model.	-	-	-	3	3	3	-	-	-	-	-	2	2	2	2
CO3	Prepare project reports and research articles for publication as a team member.	-	-	-	-	-	-	-	2	3	3	-	2	2	2	2

Course Code	Course Title	L	T	P	C
BSTS301P	Advanced Competitive Coding – I	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To develop the step-by-step approach in solving problems with the help programming techniques of data structures. 2. To deploy algorithms in real time applications.					
Course Outcomes					
At the end of the course, students will be able to 1. Provide a basic understanding of core Java concepts 2. Identify Bitwise algorithms for solving real world problems. 3. Illustrate various techniques for searching, sorting and hashing 4. Understand and implement Greedy Algorithm.					
Module:1	Algorithms	6 hours			
Java Introduction, Features, Structure, Data Types, Basic I/O Operators, Decision making and Control structure, Time & Space complexity.					
Module:2	Math based problems	6 hours			
Simple Sieve, Segmented & Incremental Sieve, Euler's phi Algorithm, Strobogrammatic Number, Remainder Theorem, Toggle the switch & Alice Apple tree, Binary Palindrome.					
Module:3	Bitwise algorithms	6 hours			
Booth's Algorithm, Euclid's Algorithm, Karatsuba Algorithm, Longest Sequence of 1 after flipping a bit Swap two nibbles in a byte					
Module:4	Arrays and searching	6 hours			
Block Swap Algorithm, Max product subarray, Maximum sum of hour glass in matrix, Max Equilibrium Sum, Leaders in array, Majority element.					
Module:5	Sorting and String	6 hours			
Lexicographically first palindromic string, Natural Sort order, Weightes substring, Move hyphen to beginning, Manacher's Algorithm					
Module:6	Recursion and Back tracking	6 hours			
Sorted Unique Permutation, Maneuvering, Combination, Josephus trap, Maze Solving, N-Queens Problem.					
Module:7	Greedy Algorithm:	6 hours			
Warnsdorff's Algorithm, Hamiltonian Cycle, Kruskal's Algorithm, Activity Selection Problem, Graph Coloring, Huffman Coding					
Module:8	Interview Preparation	3 hours			
Networking, Security, Cryption Techniques					
Total Lecture hours:					45 hours
Text Book					
1.	Mark Allen Weiss, “Data structures and algorithm analysis in C++”, 2019, 4th Edition, Pearson Education.				
Reference Books					
1.	J.P. Tremblay and P.G. Sorenson, “An Introduction to Data Structures with applications”, 2017, Second Edition, Tata Mc Graw Hill.				
2.	Richard M. Reese, Jennifer L. Reese, Alexey Grigorev , Java: Data Science Made Easy,2019,Pocket Publishing.				
Mode of Evaluation: Written assignment, Quiz, Project & FAT.					

Course Code	Course Title	L	T	P	C
BSTS302P	Advanced Competitive Coding – II	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To deploy algorithms in real time applications. 2. To develop the step-by-step approach in solving problems with the help programming techniques of data structures.					
Course Outcomes					
At the end of the course, students will be able to					
1. Identify List, Stack based algorithms for solving real world problems. 2. Illustrate various techniques for searching, sorting and hashing 3. Understand and implement Dynamic Programming. 4. Design new algorithms or modify existing algorithms for new application.					
Module:1	Linked list				6 hours
Loop Detection, Sort the bitonic DLL, Segregate even & odd nodes in a LL, Merge sort for DLL, Minimum Stack, The Celebrity problem.					
Module:2	Stack and Queue				6 hours
Iterative Tower of Hanoi, Stock Span problem, Priority Queue using DLL, Sort without extra Space, Max Sliding Window Stack permutations					
Module:3	Trees				6 hours
Recover the BST, Views of tree, Vertical order traversal, Boundary traversal.					
Module:4	Graphs				3 hours
BFS, DFS, Dial's Algorithm, Bellman-Ford Algorithm					
Module:5	Heaps				3 hours
Topological Sort, Heap Sort, Binomial heap, K-array heap Winner tree.					
Module:6	Maps, Sets and Hashing				6 hours
HashMap to Tree Map, Types of Sets, distributing items when a person cannot take more than two items of same type					
Module:7	Dynamic Programming				9 hours
Longest Common Subsequence, Longest Increasing Subsequence, Longest Bitonic Subsequence, Longest Palindromic Subsequence, Subset sum problem, 0-1 Knapsack, Traveling Salesman, Coin Change, Shortest Common Super sequence, Levenshtein Distance problem , Rod Cutting problem, Wildcard pattern matching, Pots of gold game					
Module:8	Product Company Specific Interview Preparation -2				6 hours
Operating Systems, Data Base Management Systems, Relational Data Base Management Systems.					
Total Lecture hours					45 hours
Text Book					
1.	Mark Allen Weiss, “Data structures and algorithm analysis in C++”, 2019, 4th Edition, Pearson Education.				
Reference Books					
1.	J.P. Tremblay and P.G. Sorenson, “An Introduction to Data Structures with applications”, 2017, Second Edition, Tata Mc Graw Hill.				
2.	Richard M. Reese, Jennifer L. Reese, Alexey Grigorev, Java: Data Science Made Easy, 2019 Pocket Publishing.				
Mode of Evaluation: Written Assignment, Quiz, Project & FAT.					
Recommended by Board of Studies			24-02-2023		
Approved by Academic Council			No.69	Date	16-03-2023

[illegible]

Course Code	Course Title	L	T	P	C
BECE355L	AWS for Cloud Computing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To impart knowledge on AWS cloud management tools and services for developing cost-effective and reliable cloud solutions for real-world scenarios.					
Course Outcomes					
At the end of the course, students will be able to					
1. Comprehend the AWS cloud concepts and service models.					
2. Comprehend and differentiate between various AWS core, database services and its applications.					
3. Apply appropriate security and compliance measures for cloud applications.					
4. Design scalable, fault-tolerant and cost-effective AWS solutions using core services.					
5. Apply AWS management tools, monitoring services to automate and troubleshoot tasks.					
6. Configure and manage AWS networking and content delivery services.					
Module:1	AWS Cloud Concepts	6 hours			
Introduction to Cloud Computing, Overview of AWS Cloud, Cloud Service Models: IaaS, PaaS, SaaS, Cloud Deployment Models: Public, Private, Hybrid, AWS Global Infrastructure, AWS Shared Responsibility Model.					
Module:2	AWS Core Services	8 hours			
Amazon EC2 (Elastic Compute Cloud), Amazon S3 (Simple Storage Service), Amazon RDS (Relational Database Service), Amazon VPC (Virtual Private Cloud), Amazon SQS (Simple Queue Service), Amazon SNS (Simple Notification Service).					
Module:3	AWS Database services	6 hours			
AWS Lambda, Amazon Dynamo DB, Amazon ECS (Elastic Container Service), Amazon S3 Glacier, Amazon Kinesis, Amazon Redshift, Amazon EMR (Elastic MapReduce), AWS Disaster Recovery and Backup.					
Module:4	AWS Security and Compliance	4 hours			
AWS Identity and Access Management (IAM), AWS Shared Responsibility Model in Security, AWS Key Management Service (KMS), AWS Inspector, AWS Organizations, AWS Trusted Advisor, Compliance on AWS.					
Module:5	AWS Architectural Best Practices	6 hours			
AWS Well-Architected Framework, Design Principles for AWS Cloud Architectures, Scalability and Elasticity, High Availability and Fault Tolerance, Cost optimization and AWS pricing, Performance Efficiency.					
Module:6	AWS Operational Excellence	6 hours			
AWS Management Console, AWS CLI (Command Line Interface), AWS SDKs, AWS Cloud Formation, AWS Trusted Advisor, AWS Cloud Watch, AWS Systems Manager.					
Module:7	AWS Networking and Content Delivery	7 hours			
Amazon Route 53, Amazon Cloud Front, Amazon API Gateway, AWS Direct Connect, AWS VPN (Virtual Private Network), AWS Transit Gateway.					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:				45 hours
Text Book(s)					
1. Saurabh Shrivastava , Neelanjali Srivastav , Alberto Artasanchez, “AWS for Solutions Architects”, 2 nd Edition, Packt Publishing, 2023.					
2. Ashish Prajapati , Juan Carlos Ruiz , Marco Tamassia, “AWS Cloud Computing Concepts and Tech Analogies”, Packt Publishing, 2023.					

Reference Books			
1. Logan Song, “The Self-Taught Cloud Computing Engineer”, Packt Publishing, 2023.			
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Total Laboratory Hours			30 Hours
Mode of assessment: Continuous assessment and FAT			
Recommended by Board of Studies		21.05.2024	
Approved by Academic Council		No. 74	Date 13-06-2024

[illegible]

Course Code	Course Title	L	T	P	C
BECE399J	Summer Industrial Internship	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.					
Course Outcomes					
At the end of the course, students will be able to					
1. Interpret the application of technical knowledge and professional practices in an industrial environment.					
2. Explain the engineering tools, software, and professional practices adopted in the industry.					
3. Describe the ethical, societal, environmental, and professional practices followed in the industry.					
4. Demonstrate professional competencies as an individual or team through a technical report, presentation, and continuous learning.					
Module Content		4 Weeks (28 hours)			
Four weeks of work at industry site. Supervised by an expert at the industry.					
Mode of Evaluation: Internship Report, Presentation and Project Review					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Interpret the application of technical knowledge and professional practices in an industrial environment.	2	-	-	-	-	-	-	-	-	-	-	2	2	2	2
CO2	Explain the engineering tools, software, and professional practices adopted in the industry.	-	-	-	-	2	-	-	2	-	-	-		2	2	2
CO3	Describe the ethical, societal, environmental, and professional practices followed in the industry.	-	-	-	-	-	2	2	2	-	-	-	2	2	2	2
CO4	Demonstrate professional competencies as an individual or team through a technical report, presentation, and continuous learning.	-	-	-	-	-	-	-	-	3	3	-	3	2	2	2

Course Code	Course Title		L	T	P	C
BECE497J	Project-I		0	0	6	3
Pre-requisite	NIL		Syllabus version			
			1.0			
Course Objectives						
1. To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.						
Course Outcomes						
At the end of the course, students will be able to						
1. Analyze complex engineering problem through systematic literature survey to identify appropriate objectives aligned with sustainable development goals.						
2. Apply appropriate techniques or algorithms using modern engineering tools to develop a system for diverse applications.						
3. Justify appropriate solutions to meet the defined objectives based on the performance metrics.						
4. Demonstrate the developed project through structured technical report and professional presentation.						
Module Content			(Project Duration: One Semester)			
Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.						
Can be individual work or a group project, with a maximum of 3 students.						
In case of group projects, the individual project report of each student should specify the individual’s contribution to the group project. Carried out inside or outside the university, in any relevant industry or research institution. Publications in the peer reviewed journals / International Conferences will be an added advantage.						
Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews.						
Recommended by Board of Studies			12-10-2022			
Approved by Academic Council			No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Analyze complex engineering problem through systematic literature survey to identify appropriate objectives aligned with sustainable development goals.	-	3	-	2	-	3	3	-	3	3	-	3	3	3	3
CO2	Apply appropriate techniques or algorithms using modern engineering tools to develop a system for diverse applications.	3	-	3	3	3	-	-	2	-	-	-	3	3	3	3
CO3	Justify appropriate solutions to meet the defined objectives based on the performance metrics.	-	-	3	3	3	2	2	-	-	-	3	3	3	3	3
CO4	Demonstrate the project through structured technical report and professional presentation.	-	-	-	-	-	-	-	3	3	3	-	3	-	-	-

Course Code	Course Title	L	T	P	C
BECE498J	Project-II / Internship	0	0	10	5
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.					
Course Outcomes					
At the end of the course, students will be able to					
1. Analyse complex engineering problem through systematic literature survey to identify appropriate objectives.					
2. Implement appropriate techniques or algorithms for diverse applications using modern tools.					
3. Design an innovative solution for a selected application aligned with relevant sustainable development goals.					
4. Analyse system performance metrics with defined objectives and justify suitable solutions with cost analysis for the practical application					
5. Demonstrate professional ethics, effective collaboration with team members, and commitment to lifelong learning through project work					
6. Demonstrate project outcomes and professional competencies through structured technical reports and presentations.					
Module Content		(Project Duration: One Semester)			
1. Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.					
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.					
3. Can be individual work or a group project, with a maximum of 3 students.					
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.					
5. Carried out inside or outside the university, in any relevant industry or research institution.					
6. Publications in the peer reviewed Journals / International Conferences will be an added advantage.					
Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		12-10-2022			
Approved by Academic Council		No. 68	Date	19-12-2022	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Analyse complex engineering problem through systematic literature survey to identify appropriate objectives.	-	3	-	3	-	-	-	-	-	3	-	3	3	3	3
CO2	Implement appropriate techniques or algorithms for diverse applications using modern tools.	3	-	2	3	3	-	-	3	-	-	-	3	3	3	3
CO3	Design an innovative solution for a selected application aligned with relevant sustainable development goals.	-	-	3	3	3	3	3	-	3	3	-	3	3	3	3
CO4	Analyse system performance metrics with defined objectives and justify suitable solutions with cost analysis for the practical application	-	3	-	3	3	3	3	-	-	-	3	3	3	3	3
CO5	Demonstrate professional ethics, effective collaboration with team members, and commitment to lifelong learning through project work	-	-	-	-	-	-	-	3	3	-	-	3	3	3	3
CO6	Demonstrate project outcomes and professional competencies through structured technical reports and presentations	-	-	-	-	3	-	-	3	3	3	3	3	-	-	-

Course Code	Course Title	L	T	P	C
BECE101N	Introduction to Engineering	0	0	2	1
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objective:					
- To make the student comfortable and get familiarized with the facilities available on campus - To make the student aware of the exciting opportunities and usefulness of engineering to society - To make the student understand the philosophy of engineering					
Course Outcome:					
At the end of the course, the student will be able to:					
1. Participate in general and discipline-specific induction activities. 2. Familiarize with the infrastructure facilities available on campus. 3. Prepare a structured report on induction activities and observations.					
General Guidelines					
1. Student should observe and involve in the activities during the induction programme. Both general activities and those which are discipline-specific should be included here. 2. Student should get familiarized with the infrastructure facilities available on campus during the general induction, school induction programme and also from the institutional website. 3. Student should attend the lecture by industries, including those on career opportunities, organized by the school and probably involve in ‘Do-it-yourself’ projects or projects involving reverse-engineering. 4. Activities under ‘Do-it-Yourself’ will be detailed by the school. 5. Student should prepare a report on the activities and observations, as per the specified format, and submit the same in institutional LMS, VTOP for further evaluation. General instruction on formatting: Document to be prepared with the titles given in the template; Arial type with font size of 12 to be used; photographs can be included in the document as per the requirement; 1.5-line spacing to be used.					
Mode of Evaluation: Evaluation of the submitted report and interaction with the students					
Recommended by Board of Studies		02.07.2021			
Approved by Academic Council		No. 63	Date	23.09.2021	

CO	Course outcomes	Program Outcomes												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	Participate in general and discipline-specific induction activities.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CO2	Familiarize with the infrastructure facilities available on campus.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CO3	Prepare a structured report on induction activities and observations.	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

Course Code	Course Title	L	T	P	C
BSSC101N	Essence of Traditional Knowledge	2	0	0	2
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives:					
1. To impart the knowledge on Indian tradition and Culture. 2. To enable the students to acquire the traditional knowledge in different sectors. 3. To analyze and understand the Science, Management and Indian Knowledge System.					
Course Outcomes:					
At the end of the course, students will be able to 1. Familiarize the concept of Traditional Indian Culture and Knowledge. 2. Explore the Indian religion, philosophy and practices. 3. Analyze and understand the Indian Languages, Culture, Literature and Arts. 4. Gives a clear understanding on the Indian perspective of modern scientific world and basic principles of Yoga and holistic health care system of India. 5. Enable knowledge on Legal framework and traditional knowledge.					
Module:1	Introduction to Traditional Knowledge				
Traditional knowledge: Definition, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge, characteristics, Traditional knowledge vis-a- vis Indigenous knowledge, Traditional knowledge Vs Western Knowledge.					
Module:2	Culture and Civilization				
Introduction to Culture and Civilization, Culture and Heritage, Characteristics features of Indian Culture, Importance of Culture, Cultural practices in Ancient India, Medieval India and Modern India.					
Module:3	Languages and Literature				
Indian Languages and Literature: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature and literatures of South India.					
Module:4	Religion and Philosophy				
Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only).					
Module:5	Fine Arts in India				
Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama. Science and Technology in India, Development of science in ancient, medieval and modern India. Traditional Medicine — Herbal Healing - Yoga and Pranayama practices.					
Module:6	Traditional Knowledge in different sectors				
Traditional knowledge and engineering, Traditional medicine system, Traditional knowledge in agriculture, Dependence of Traditional Societies on food and healthcare needs; Importance of conservation and sustainable development of environment, Management of biodiversity and Protection of Traditional knowledge.					
Module:7	Legal framework and Traditional Knowledge				
Introduction on Legal framework and Traditional Knowledge: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, The protection of traditional knowledge bill, 2016.					
Total Lecture Hours:					60 hours
Text Books:					
1.	Shikha Jain, Parul G Munjal And Somya Joshi,(2020) Traditional Knowledge Systems and Cultural Heritage, Aryan Books International, India.				

2.	Anindya Bhukta(2020), Legal Protection for Traditional Knowledge: Towards A New Law for Indigenous Intellectual Property, Emerald Publishing Limited, United Kingdom.		
Reference Books:			
1.	Traditional Knowledge System in India, by Amit Jha, 2009.		
2.	Basant Kumar Mohanta & Vipin Kumar Singh (2012), “Traditional Knowledge System & Technology in India”, Pratibha Prakashan, India.		
3.	S. Baliyan, Indian Art and Culture, Oxford University Press, India.		
4	http://indiafacts.org/author/michel-danino/		
5.	GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi,2016.		
Mode of Evaluation: Quiz and Term End – Quiz			
Recommended by Board of Studies		16-11-2021	
Approved by Academic Council		No. 64	Date 16-12-2021

Course Code	Course Title	L	T	P	C
BSSC102N	Indian Constitution	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
This Course is an introduction of Indian Constitution and basic concepts highlighted in this course for understanding the Constitution of India.					
Course Outcome					
At the end of the course, students will be able to					
1. A basic understanding of Constitution of India.					
2. The ability to understand the contemporary challenges and apply the knowledge gained from the course to current social contemporary legal issues.					
3. The understanding of constitutional remedies.					
Module:1	Introduction to Indian Constitution	5 hours			
Introduction to the constitution of India and the Preamble - Sources of Indian Constitution - Features of Indian Constitution - Citizenship - Fundamental Rights and Duties - Directive Principles of state policy					
Module:2	Union Government and its Administration Structure of the Indian Union	8 hours			
Federalism, Centre- State relationship - President: Role, Power and Position - Prime Minister and Council of ministers - Cabinet and Central Secretariat - Lok Sabha - Rajya Sabha- The Supreme Court and High Court: Powers and Functions					
Module:3	State Government and its Administration	4 hours			
Governor- Role and Position - Chief Minister and Council of Ministers - State Legislative Assembly - State secretariat: Organization, Structure and Functions					
Module:4	Local Administration	7 hours			
District's Administration Head- Role and Importance - Municipalities: Introduction, Mayor and role of Elected Representative - Panchayati Raj: Composition and Functions Evolution and 73rd and 74th Amendments - Zila Parishad and district administration: Composition and Functions Elected officials and their roles, CEO Zila Panchayat: Position and role- Panchayat Samiti: Composition and Functions - Gram Panchayat: Composition and Functions Importance of grass root democracy.					
Module:5	Election Commission	6 hours			
Role of Chief Election Commissioner - State Election Commission - Functions of Commissions for the welfare of SC/ST/OBC and women.					
	Total Lecture hours:	30 hours			
Reference Books					
1.	Durga Das Basu, Introduction to the Constitution of India, Gurgaon; LexisNexis, 2018 (23rd edn.)				
2.	M.V.Pylee, India's Constitution, New Delhi; S. Chand Pub., 2017 (16th edn.)				
3.	J.C Johari, Indian Government and Politics, Shoban Lal & Co., 2012				
4.	Noorani, A.G , Challenges to Civil Rights Guarantees in India, Oxford University Press 2012.				
5.	R. Bhargava, (2008) 'Introduction: Outline of a Political Theory of the Indian Constitution', in R. Bhargava (ed.) Politics and Ethics of the Indian Constitution, New Delhi: Oxford University Press.				
6.	Bidyut Chakrabarty & Rajendra Kumar Pandey, Indian Government and Politics, SAGE, New Delhi, 2008				

7.	G. Austin, The Indian Constitution: CornerStone of a Nation, Oxford, Oxford University Press, 1966		
Mode of Evaluation: CAT, Written assignment, Quiz and FAT			
Recommended by Board of Studies		27-10-2021	
Approved by Academic Council		No. 68	Date 19-08-2022

Course Code	Course Title	L	T	P	C
BCHY102N	Environmental Sciences	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
The course is aimed at students to					
1. Understand and appreciate the unity of life in all its forms and their implications of life style on the environment.					
2. Identify the different causes for environmental degradation.					
3. Analyze individual’s contribution to environmental pollution.					
4. Evaluate the impact of pollution at the global/local level and find solutions for remediation.					
Course Outcomes					
At the end of the course, the students will be able to					
1. Summarize global environmental issues from a problem-oriented, interdisciplinary perspective.					
2. Apply scientific principles to solve key environmental issues through sustainable practices					
3. Demonstrate the significance of biodiversity and its preservation					
4. Identify various environmental hazards and ways to mitigate them					
5. Apply various techniques for conservation of resources					
6. Apply sustainable alternates that incorporate sciences, humanity and social aspects to reduce problems affecting the ecosystem.					
Module: 1	Environment and Ecosystem	5 hours			
Environment: definition; Earth–life support system. Ecosystem definition, components and types. Key environmental problems, their basic causes and sustainable solutions. Food chain, food web and their significance, Energy flow in ecosystem; Ecological succession- stages involved, primary and secondary succession - hydrarch, mesarch, xerarch.					
Module: 2	Biodiversity	4 hours			
Biodiversity-definition, levels and importance. Species: roles: types: extinct, endemic, endangered and rare species. Hot-spots –Significance, Mega-biodiversity. Threats to biodiversity due to natural and anthropogenic activities, Conservation methods. GM crops- advantages and disadvantages.					
Module: 3	Sustaining Environmental Quality	4 hours			
Environmental hazards: definition, types, causes and solutions: Biological (Malaria, COVID-19), Chemical (BPA, heavy metals), and Nuclear (Chernobyl); Air, water and soil quality management and conservation; Solid waste management methods.					
Module: 4	Clean and Green Energy	5 hours			
Renewable energy resources: Solar energy-thermal and photovoltaic; Hydroelectric energy. Wind energy, Ocean thermal energy; Geothermal energy; Energy from biomass; Hydrogen energy; Solar-hydrogen revolution. Electric and CNG vehicles.					
Module: 5	Environmental Protection Policies	4 hours			
Environmental Protection (EPA) objectives; Air Act, water Act, Forest conservation Act and Wild life protection Act. Environmental Impact Analysis: guidelines, core values. Impact assessment methodologies.					
Module: 6	Sustainable development	4 hours			
Effect of population-urban environmental problems; Population age structure; Sustainable human societies: tools in economics, sustainable development goals SDGs and promoting awareness. Women and child welfare, Women empowerment.					

Module: 7	Global Climate Change	4 hours
Global climate change and green-house effect. Kyoto Protocol-carbon credits, The Paris Agreement, carbon sequestration: definition, types and methodologies. Ozone layer depletion: causes and impacts. Mitigation of ozone layer depletion- Montreal Protocol. Role of Information Technology in environment.		
Total Lecture hours:		30 hours
Assessment: Seminars, Quiz, Case Studies, Final Assessment Test.		
Text Books		
1. G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15 th Edition, Cengagelearning. 2. Benny Joseph, (2012), Environmental Science and Engineering, 5 th Edition, Tata McGraw Hill Education Private Limited, New Delhi, India.		
Reference Book(s)		
1. David M. Hassenzahl, Mary Catherine Hager, Linda. R. Berg (2011), Visualizing Environmental Science, 4 th Edition, John Wiley & Sons, USA. 2. Raj Kumar Singh, (2012), Environmental Studies, Tata McGraw Hill Education Private Limited, New Delhi, India. 3. George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17 th Edition, Brooks/Cole, USA.		
Recommended by Board of Studies		14-02-2022
Approved by Academic Council	No. 65	Date 17-03-2022

[illegible]

Course Code	Course Title	L	T	P	C
BHUM101N	Ethics and Values	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					

2.	Blackburn, S. “Ethics: A Very Short Introduction”, 2001, Oxford University Press.		
3.	Dhaliwal, K.K , “Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts”, 2016, Writers Choice, New Delhi, India.		
4	Ministry of Social Justice and Empowerment, “Magnitude of Substance Use in India”, 2019, Government of India.		
5.	Ministry of Home Affairs, “Accidental Deaths and Suicides in India”, 2019, Government of India.		
6.	Ministry of Home Affairs, “A Handbook for Adolescents/ Students on Cyber Safety”, 2018, Government of India.		
Mode of Evaluation: Poster making, Quiz and Term End - Quiz			
Recommended by Board of Studies		27-10-2021	
Approved by Academic Council		No. 64	Date 16-12-2021