Bachelor of Honours in Electronics and Computer Science Degree Programme

Course Structure

Semesters	Course Code	Course Name	Credit Value	Status*			Existing/New
				Electronics & Computer Science Domain	Specialisation in Electronics Domain	Specialisation in Computer Science Domain	
1	BECS 11212	Foundations in Computer Science	2	C	C	C	New
	BECS 11223	Fundamentals of Programming	3	C	C	C	New
	BECS 11413	Analogue Electronics I	3	C	C	C	New
	BECS 11422	Electric Circuit Fundamentals	2	C	C	C	New
	BECS 11431	Analogue Electronics Laboratory I	1	C	C	C	New
	BECS 11613	Applied Algebra & Statistics	3	C	C	C	New
	BECS 11722	Fundamentals of Management Accounting	2	O	O	O	New
	ACLT 11013	Academic Literacy I	3	C	C	C	Ex
2	BECS 12233	Data Communications and Networks	3	C	C	C	New
	BECS 12243	Object Oriented Programming	3	C	C	C	New
	BECS 12443	Digital Electronics	3	C	C	C	New
	BECS 12451	Digital Electronics Laboratory	1	C	C	C	New
	BECS 12462	Mechanics & Properties of Materials	2	C	C	C	New
	BECS 12623	Calculus	3	C	C	C	New
	BECS 12712	Foundation Course in English	2	O	O	O	New
	BECS 12742	Project Management and Financing	2	O	O	O	New
3	BECS 21213	Software Engineering	3	C	C	C	New
	BECS 21223	Data Structures and Algorithms	3	C	C	C	New
	BECS 21413	Analogue Electronics II (Operational Amplifiers)	3	C	C	C	New
	BECS 21422	Electromagnetism	2	C	C	C	New
	BECS 21431	Analogue Electronics Laboratory II	1	C	C	C	New
	BECS 21613	Differential Equations, Integral Transforms & Numerical Methods	3	C	C	C	New
	BECS 21732	Professional English	2	O	O	O	New
	BECS 21722	Organizational Behaviour	2	O	O	O	New
4	BECS 22233	Computer Architecture and Operating Systems	3	C	C	C	New
	BECS 22243	Database Management Systems	3	C	C	C	New

	BECS 22253	Web & Internet Technologies	2	C	C	C	New
	BECS 22443	Measurement & Instrumentation	3	C	C	C	New
	BECS 22451	Measurement & Instrumentation Laboratory	1	C	C	C	New
	BECS 22462	Signals and Systems	2	C	C	C	New
	BECS 22623	Implementation of Numerical Methods using appropriate software	3	C	C	C	New
	BECS 22811	Creative Design Project I	1	C	C	C	New
	BECS 22712	English in Today's World	2	O	O	O	New
	BECS 22732	Marketing Fundamentals	2	O	O	O	New
5	BECS 31213	Enterprise Software Design and Architecture	3	C	-	C	New
	BECS 31223	Cyber Security and Forensics	3	C	-	C	New
	BECS 31412	Microcontrollers and Embedded Electronics	2	C	C	-	New
	BECS 31421	Microcontrollers and Embedded Electronics Laboratory	1	C	C	-	New
	BECS 31433	Communication Systems	3	O	C	-	New
	BECS 31443	Control Systems Design	3	C	C	-	New
	BECS 31712	Technical Communication	2	O	O	-	New
	BECS 31722	Introduction to Entrepreneurship	2	O	-	-	New
	BECS 31732	Legal Environment of Business	2	O	-	-	New
6	BECS 32232	Human Computer Interaction	2	O	-	C	New
	BECS 32243	Visual Programming	3	O	-	C	New
	BECS 32253	Intelligent Systems	3	O	O	-	New
	BECS 32263	Full-stack Software Development	3	O	-	O	New
	BECS 32272	Mobile Application Development	2	O	O	O	New
	BECS 32453	Digital Signal Processing (DSP)	3	C	C	-	New
	BECS 32461	Digital Signal Processing Laboratory	1	C	C	-	New
	BECS 32472	Programmable Logic Devices and HDL	2	O	O	-	New
	BECS 32482	Robotics & Automation	2	O	O	-	New
	BECS 32492	Electrical Machines & Drives	2	O	O	-	New
	BECS 32502	Micro-Electro Mechanical Systems (MEMS)	2	O	O	-	New
	BECS 32811	Creative Design Project II	1	C	C	-	New
	BECS 32742	Operations Management	2	O	-	-	New
7 & 8	BECS 44213	Wireless Communication and Networks	3	C	O	C	New
	BECS 44223	Blockchain and Cryptocurrency	3	O	-	C	New
	BECS 44233	Computer Graphics and Visualization	3	C	-	C	New
	BECS 44243	High Performance Computing	3	O	-	O	New
	BECS 44253	Emerging Technologies in Computer Science	3	C	-	C	New
	BECS 44263	Machine Learning	3	O	O	O	New
	BECS 44273	Game Development	3	C	-	O	New
	BECS 44283	Advanced Databases	3	O	-	O	New
	BECS 44414	Power Electronics	4	C	C	-	New
	BECS 44424	CMOS VLSI system design	4	O	C	-	New
	BECS 44434	Special Topics in Electronics	4	O	O	-	New
	BECS 44443	RF & Microwave Circuits Design	3	O	O	-	New
	BECS 44453	Industrial Electronics	3	O	O	-	New
	BECS 44462	Industrial Automation	2	O	O	-	New
	BECS 44716	Industrial Training	6	C	-	O	New
	BECS 44472	Electronics Product Design & Manufacturing	2	O	O	-	New
	BECS 43816	Research Project (Group)	6	C	-	-	New
5 & 6	BECS 43033	Advanced Experimental Laboratory I	3	-	C	-	New
6	BECS 44014	Advanced Analogue Electronics	4	-	C	-	New
	BECS 44024	Advanced Electromagnetism	4	-	C	-	New
7 & 8	BECS 43818	Research Project (Individual)	8	-	C	C	New
	BECS 43043	Advanced Experimental Laboratory II	3	-	C	-	New
	BECS 44053	Optoelectronics	3	-	O	-	New
	BECS 44062	Modern Radar Systems	2	-	O	-	New
	BECS 44072	Physics of Semiconductor Devices	2	-	O	-	New
	BECS 44082	Semiconductor Device Processing & Fabrication	2	-	O	-	New
5	BECS 44613	Data Science	3	-	-	C	New

	BECS 44622	Big Data Technologies	2	-	-	C	New
	BECS 44633	Object-Oriented Analysis and Design	3	-	-	C	New
	BECS 44642	Systems Administration	2	-	-	O	New
6	BECS 44653	Logic Programming	3	-	-	C	New
	BECS 44663	Digital Image Processing and Computer Vision	3	-	-	O	New
	BECS 44673	Theory of Computing	3	-	-	O	New
	BECS 44683	Theory of Compilers	3	-	-	C	New
	BECS 44692	Research Methodologies	2	-	-	O	New
7 & 8	BECS 44703	Multimedia Systems Development	3	-	-	O	New
	BECS 44713	Natural Language Processing	3	-	-	O	New
	BECS 44723	Semantic Web and Ontological Modelling	3	-	-	O	New
	BECS 44733	Cloud Computing	3	-	-	O	New
	BECS 44743	System Level Programming	3	-	-	O	New
	Total from Compulsory Courses			107	106	110	
	Total from Optional Courses			77	61	60	
				Electronics & Computer Science Domain	**Specialisation in Electronics Domain**	**Specialisation in Computer Science Domain**	

Detailed Syllabuses

Semester 1			
Course Code:	BECS 11212		
Course Name:	Foundations in Computer Science		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	G.C.E. (A/L)		
Co-Requisites	BECS 11223		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- explain how data are represented, stored, and manipulated by computer hardware
- use abstraction and decomposition when reasoning about complex systems and problems
- describe how data can be transmitted over networks and the security concerns that arise
- apply computing tools and techniques to solve problems at multiple levels of abstraction
- discuss the impact of computing within economic, social, and cultural contexts
- recognize problem solving techniques and algorithm development using computers.

Course Content:

Main components of a Computer; Organization of a Computer; Classification of Computers; Software: Systems Software and Application Software; Operating Systems, functions and types of operating systems; Utility Programs, Translators (compilers, interpreters, assemblers); Application Programs: Algorithms, Computer

programs, Computer programming Languages; Generations of programming languages; Number Systems; Conversions between number systems; Use of number systems; Binary addition and subtraction; Representation of Numbers; Representation of Characters: ASCII, EBCDIC, Unicode; Representation of Images and Video; Introduction to logic gates; Introduction to Computer Networks; Network topologies; Advantages and disadvantages of computer networks, Introduction to the Internet; Services available on the Internet; Information Systems; Systems Development Life Cycle (SDLC); Social, Ethical, Legal and Economic impacts of the use of computers; Computer crime.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Group Projects, Student-centred discussions

Assessment Strategy:

Continuous Assessment (50%)	Final Assessment (50%)		
Details: Quizzes 10, Assignment 30, Attendance 10	Theory 50	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Norton, P. (2006). Introduction to Computers. 6th Edition. Tata McGraw-Hill Publishing Company limited, India.
2) Parsons, J. J., Oja, D. (2003). New Perspective on Computer Concepts. 6th Edition. Course Technology a division of Thomson learning Inc.
3) Ram, B. (2005). Computer Fundamentals: Architecture and organization. 3rd Edition. New Age Publications, India.
4) Forouzan, B. A., Firouz, M. (2008). Foundations of Computer Science. 2nd Edition. Cengage Learning EMEA.
5) Gaddis, T. (2017). Starting out with Python. 4th Edition. Pearson.

Semester 1

Course Code:	BECS 11223		
Course Name:	Fundamentals of Programming		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	G.C.E. (A/L)		
Co-Requisites	BECS 11212		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- define the basic concepts of the structured programming
- identify suitable data types and data structures for the real-world problems
- explain main control structures of procedural programming languages
- develop structured programs using a procedural language
- describe functional hierarchical code organization
- demonstrate knowledge on textual information, characters and strings
- use language specific features on program development and error handling.

Course Content:

Introduction to Programming: A brief history and types of programming languages; Program Design: Modular programming concepts, Elegance in program design Implementing an algorithm using a programming language Program testing and program; The High Level programming language: First program, compilation, syntax errors, Data types and variable scopes, Constants, Identifiers, Expressions and assignment, Input and output, Arrays, Program selections (if, if-else, switch), Repetition (for, do-while), Control structures; Introduction to Functions; Storage classes; Scope of a variable; Pointers; Structured data types (arrays, structures, unions), Programmer defined data types; Recursion; Inheritance; Virtual Functions, and Dynamic Binding; File processing; Multi-file programming; Bit manipulation and enumerations; Static and Dynamic memory handling; error handling (debugging).

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Project Works, Student-centred discussions

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (30%)	Final Assessment (70%)

Details: Quizzes 5, Assignment 15, Attendance 10	Theory 40	Practical 30	Other(specify) N/A

References/Reading Materials:

1) Gottfried, B.S. (2001). Schaum's Outline of Theory and Problems of Programming in C. 2nd Edition. McGraw Hill Professional Publishing.
2) Gaddis, T. (2017). Starting out with Python. 4th Edition. Pearson.
3) Kelly, A. and Pohl, I. (1999). A Book on C: Programming in C. 4th Edition. Addison Wesley Longman Inc.
4) Rajaraman, V. (2004). Computer Programming in C. 6th Edition. Prentice Hall.
5) Zelle, J. M. (2016). Python programming: an introduction to computer science. 3rd Edition. Franklin, Beedle & Associates, Inc.
6) Guttag, J. (2016). Introduction to Computation and Programming Using Python: With Application to Understanding Data. 2nd Edition. MIT Press.

Semester 1			
Course Code:	BECS 11413		
Course Name:	Analogue Electronics I		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	A/L Physics		
Co-Requisites	BECS 11431 Analogue Electronics Laboratory I		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to demonstrate:

- the understanding of Semiconductor Fundamentals
- the understanding of p-n junction diode and its applications
- basic knowledge on BJT, FET and their applications
- the ability in analysing BJT circuits using small signal parameters
- basic knowledge of transistor amplifiers and oscillators
- basic knowledge on CMOS devices
- ability in solving problems of analogue electronics

Course Content:

Semiconductor fundamentals, Intrinsic semiconductors, Extrinsic semiconductors, p-n junction, Semiconductor diodes: Diode and diode circuits, Rectifier circuits, Filters, Clippers, Clamping circuits, Voltage multipliers. Bipolar junction transistors: Characteristics of transistor configurations, Operating point, Transistor biasing, Equivalent circuits, Small signal parameters. Amplifiers: Single stage amplifiers, Multistage amplifiers, Comparison of different types of coupling, Frequency response, Negative feedback, Positive feedback, Oscillators, Transistor tuned amplifiers. Basics of power amplifiers, Transistor audio power amplifiers, Amplifiers with negative feedback, Field effect transistors, CMOS devices, Switching circuits

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Floyd, T. L., (2017), Electronic Devices, 10th Edition (Electron Flow Version), Prentice-Hall International
2) Razavi, B., (2013), Fundamentals of Microelectronics, 2nd Edition, Wiley
3) Jaeger, R. C. & Blalock, T. N., (2016), Microelectronic Circuit Design, 5th Edition, McGraw-Hill
4) Sedra, A. S. & Smith, K. C., (2010), Microelectronic Circuits, 6th Edition, Oxford University Press

Semester 1	
Course Code:	BECS 11422
Course Name:	Electric Circuit Fundamentals
Credit Value:	2

Compulsory/Optional	Compulsory		
Pre-Requisites	A/L Physics		
Co-Requisites	BECS 11431 Analogue Electronics Laboratory I		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- use network theorems to analyse and simplify electric circuits
- do mesh-current and node voltage analysis
- calculate steady-state responses of circuits containing passive elements
- design and analyse LCR resonance circuits and obtain their characteristics
- understand the basics of three-phase electric circuits

Course Content:

Electric circuit analysis: Network theorems: Ohm's law, Kirchhoff laws, Mesh and Nodal analysis, Thévenin's theorem, Norton's theorem, Superposition theorem. Introduction to complex numbers used in AC circuits, Current electricity, Constant voltage source, Constant current source, Conversion of voltage source into equivalent current source and vice-versa, Loop equations and loop analysis, Maximum power transfer and matching theorems, Delta-star transformation, Star-delta transformation, Self-inductance and mutual inductance, Series and parallel inductors, A/C circuits of Inductors (L), Capacitors (C) and resistors (R), Alternating current theory, Vector method for L-C-R series and parallel circuits, Power dissipation of L-C-R circuit, Power factor, Quality factor, Resonance and band width, AC bridges., Three-phase circuits, Three-phase sources, Balanced 3-phase circuits, Analysis of Y-Y circuits, Analysis of Y-Δ circuits, Power calculations in balanced three-phase circuits

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Shepherd, J., Morton, A. H. & Spence, L. F., (1998), Higher Electrical Engineering, Prentice-Hall
2) Alexander, C. & Sadiku, M. N. O., (2012), Fundamentals of Electric Circuits, 5th Edition, McGraw-Hill
3) Purcell, E. M.& Morin, D. J., (2013), Electricity and Magnetism, 3rd Edition, Cambridge University Press

Semester 1			
Course Code:	BECS 11431		
Course Name:	Analogue Electronics Laboratory I		
Credit Value:	1		
Compulsory/Optional	Compulsory		
Pre-Requisites	A/L Physics		
Co-Requisites	BECS 11413 Analogue Electronics I and BECS 11422 Electric Circuit Fundamentals		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	20

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- use electrical test and measuring instruments such as Oscilloscopes, Signal generators, Multimeter accurately & effectively
- gain experimental skills on fundamental concepts of analogue electronics and electric circuit fundamentals
- present experimental data using graphical methods such as graphs
- write technical reports by analysing experimental data

Course Content:

Semiconductor diode characteristics, Rectifier circuits, Filters, Clippers, Clamping circuits. Bipolar junction transistors: Characteristics of transistor configurations, Frequency response, Single stage amplifiers, Negative feedback, Oscillators, Transistor audio power amplifiers, Field effect transistors characteristics, Electric circuit analysis

Teaching/Learning Methods:
10 lab sessions per semester (one 3hr laboratory session per week)

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Lab reports 40, Attendance 20	Theory N/A	Practical 30	Other(specify) 10 for Oral presentation or Viva

References/Reading Materials:

1) Floyd, T. L., (2017), Electronic Devices, 10th Edition (Electron Flow Version), Prentice-Hall International
2) Razavi, B., (2013), Fundamentals of Microelectronics, 2nd Edition, Wiley
3) Jaeger, R. C. & Blalock, T. N., (2016), Microelectronic Circuit Design, 5th Edition, McGraw-Hill
4) Alexander, C. & Sadiku, M. N. O., (2012), Fundamentals of Electric Circuits, 5th Edition, McGraw-Hill

Semester 1			
Course Code:	BECS 11613		
Course Name:	Applied Algebra and Statistics		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	A/L Combined Mathematics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- demonstrate the operations of complex numbers and use the polar and exponential forms to solve complex equations
- determine the types of functions and identify the inverse function
- use matrices and determinants to solve systems of linear equations
- calculate probabilities of random events and apply several discrete and continuous probability models in statistical applications

Course Content:
Complex Numbers: Properties of operations of complex numbers, The complex plane, Polar form, DeMoivre's theorem, Euler's form, Roots of complex polynomials, n th roots of 1 and -1
Relations and functions: Basic definitions, Composition of functions, Injections, Surjections, Bijections, Inverse functions
Matrices and linear equations: Matrix algebra, Determinants, Elementary row operations, Solving of linear equations
Probability: Definitions, Rules and application of probability, Conditional probability, Independence, Bayes' theorem
Statistics : Random variables, Discrete probability tables, Mean and standard deviation, Binomial, Poisson and Geometric distributions, Exponential and Normal distributions, Applications of probability distributions

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Johnsonbaugh, R., (2007), Discrete Mathematics, 7th Edition, Pearson
2) Murray, R. S., (2009), Complex Variables, 2nd Edition, McGraw-Hill, New York
3) Peck, R., Olsen, C., Devore, J., (2015), Introduction to Statistics and Data Analysis, 5th Edition, Brooks Cole

Semester 1	
Course Code:	BECS 11712
Course Name:	Foundation Course in English

Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- initiate conversations: greeting, introduction, small talk, farewell, give and ask for directions
- handle telephone conversations in English: initiate calls, answer calls, ask/give information on the phone
- use markers of politeness appropriately
- listen to lectures and take down lecture notes in English
- make effective presentations
- do reference in English
- use appropriate vocabulary related to the sciences
- write laboratory reports
- provide summaries of written and spoken material
- read and understand subject-related material in English
- identify and avoid common errors in pronunciation

Course Content:

Dialogues, Short speeches, Social chit-chat etc., Introduction to academic writing. Presentation skills. Note-taking skills. How to use the dictionary? Reading material from students' areas of study. Authentic reading material from newspapers, magazines etc. Listening material prepared by the ELTU using extracts from the public domain

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions, Guest lectures, Workshops

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Listening and speech tests 10, Assignment 10, Attendance 10	Theory 70	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Donovan, P., (1978), Basic English for Science, Oxford University Press, Madras
2) Folse, K. S., Mahnke, M. K., Solomon, E. V., Williams, L., (2003), Blueprints 1: Composition, Skills for Academic Writing, Houghton Mifflin Company
3) Lefevre, C. A. & Lefevre, H. E., (1978), Reading Power and Study Skills for College Work, Harcourt Brace Jovanovich Inc. New York
4) McCarthy, M. & O'Dell, F., (1999), English Vocabulary in Use, (Intermediate), Cambridge University Press, Cambridge
5) Murphy, R., (1992), Essential English Grammar, Cambridge University Press, Cambridge
6) Pearson, I., (1978), English in Focus: English in Biological Science, Oxford University Press

Semester 1			
Course Code:	BECS 11722		
Course Name:	Fundamentals of Management Accounting		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate broad knowledge uses of financial accounting and management accounting
- develop initial arguments and make some judgements in accordance with basic theories and concepts of the area of study
- present and interpret how to analyse and control costs within an organization
- carry out various costing methods to determine cost of a product

- prepare management reports

Course Content:
The role and scope of cost and management accounting, Classification of costs, Cost allocation, Introduction to cost terms and purposes, Accounts for materials, Labour and overhead, Costing systems; Job costing, Process costing, Joint product and by product costing, Activity based costing, Absorption and marginal costing. Cost volume profit analysis. Management Accounting practices in business organization, The need for financial planning, Forecasting and budgeting

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Assignment 20, Attendance 10, Presentation 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Arora, M. N., (2009), Cost Accounting, Principles and Practice, 12th Edition, Vikas Publishing House Pvt Ltd.
2) Drury, C., (2015), Management and Cost Accounting, 9th Edition, Akash Press, New Delhi
3) Horngren, C. T., Foster, G., Datar. S. M., (2014), Cost Accounting: A Managerial Emphasis, 15th Edition, Pearson

Semester 4

Course Code:	BECS 12233		
Course Name:	Data Communication and Networks		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11212		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- examine the use of computer networks to identify the forces behind their development
- explain the principles of a layered protocol architecture
- identify and describe the system functions in the protocol layers
- discuss different coding schemes
- design various network topologies, architectures, protocols and algorithms.

Course Content:
Introduction**:** Data communication, network structures, types of networks, the Internet, protocols and standards, layers of the OSI model; The physical layer**:** Transmission media (guided and unguided), analog and digital transmission, transmission impairment, encoding techniques, modulation techniques and modems, multiplexing, circuit switching and packet switching; Telephone Networks and DSL technology; The medium access sub-layer**:** Ethernet (CSMA/CD), token bus, token ring and FDDI; The data link layer**:** Framing, error detection and correction, error control and flow control, data link protocols; The network layer**:** Addressing, routing algorithms, internetworking and network layer protocols; The transport layer**:** Transport layer protocols (UDP and TCP) and connection management; The session layer**:** Token management and synchronization; The presentation layer**:** Data compression, data security and encryption; The application layer**:** Client-Server model, application level protocols for file transfer, electronic mail, network management, Hypertext transfer and World Wide Web; Advanced telecommunication services and developments: ISDN, Frame Relay Networks, ATM Networks, packet switching and X.25 Networks; LAN, MAN, WAN and Networking software; Networking and Internetworking Devices.

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Stallings, W. (2013). Data and computer communications. 10th Edition. Pearson.
2) Forouzan B. A. (2012). Data Communications and Networking. 5th Edition. McGraw Hill.
3) Tanenbaum A.S., Wetheral David J. (2010). Computer Networks. 5th Edition. Prentice-Hall International.
4) Kurose, J. F., Ross, K. W. (2016). Computer networking: a top-down approach. 7th Edition. Pearson.
5) Stallings, W., Case, T. (2012). Business Data Communications- Infrastructure, Networking and Security. 7th Edition. Pearson.

Semester 2			
Course Code:	BECS 12243		
Course Name:	Object Oriented Programming		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- apply design and development principles in the construction of software systems of varying complexity
- develop the structures to represent objects and the algorithms to perform operations
- explain and utilize object-oriented concepts
- use an industry-leading Integrated Development Environment (IDE) to develop and manage software projects.

Course Content:

Background and motivation of Object Oriented Methods; Concepts of Object Oriented project management issues; Principles and features of an industry standard Object Oriented Programming Language (OOPL) (e.g.: Java/C++); Basic OOPL features: Class and object models, object declaration and creation, instantiable classes, visibility modifiers, arrays of objects, self-referencing pointers, reuse of code, static methods, arithmetic expressions, variables, scope, Event Driven input and output, file objects and looping statements, primitive and reference types, strings, use of string buffer, passing objects as parameters, exceptions; Advanced OOPL features: Overloading, data abstraction, encapsulation, inheritance, polymorphism, file processing, templates, exceptions and container classes.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Individual and Group Projects, Student-centred discussions

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (40%)	Final Assessment (60%)		
Details:	Theory	Practical	Other(specify)
Quizzes 5, Assignment 25, Attendance 10	40	20	N/A

References/Reading Materials:

1) Wu, T. (2009). An Introduction to Object-Oriented Programming with Java. 5th Edition. McGraw Hill.
2) Savitch, W. (2017). Problem Solving with C++. 10th Edition. Pearson.
3) Liang, Y. D. (2017). Introduction to Java Programming and Data Structures, Comprehensive Version. 11th Edition. Pearson.
4) Dale, N. B., Weems, C. (2004). Programming in C++. 3rd Edition. Jones & Bartlett Learning.
5) Gamma, E. (1995). Design patterns: elements of reusable object-oriented software. Pearson Education, India.

Semester 2			
Course Code:	BECS 12443		
Course Name:	Digital Electronics		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11413 Analogue Electronics I		
Co-Requisites	BECS 12451 Digital Electronics Laboratory		
Hourly Breakdown	Theory	Practical	Independent Learning

	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand the difference between analogue and digital electronics
- describe different number systems, their operations and application in digital electronics
- use Boolean algebra, Karnaugh map to simplify logic operations
- demonstrate basic knowledge on digital logic gates and their uses in simple logic circuits
- design and implement combinational and sequential logic circuits

Course Content:

Digital and analogue quantities, Number systems, Binary numbers, Conversion from decimal to binary & vice versa, Binary arithmetic, Binary addition, Binary subtraction, Binary mortification, Binary division, 1's & 2's complements of binary numbers, Signed numbers, Floating point numbers, Hexadecimal numbers, Octal numbers, Binary coded decimal (BCD), 8421 code, Gray code, Error detection & Correction codes, Parity, Hamming code, Logic gates (TTL and CMOS gates), Gate universality, Boolean algebra, Laws and rules of Boolean algebra, Truth tables, Logic symbols, Logic implementation, Sum-of-products, Product-of-sums, De Morgan's theorem, Karnaugh map simplification, SOP & POS minimization, Functions of combinational logic (adders, comparators, decoders, encoders, multiplexers, demultiplexers), Digital logic with feedback (multivibrators, latches, Flip-Flops), Edge triggered latches, Sequential circuits (counters in sequential system, synchronous and asynchronous counters, Up/Down modes, Sequence detectors, Shift registers), Moore and Mealy circuits, Memory (RAM, 1-D/2-D memory chips, ROM, PROM, EPROMS, PLA, Dynamic RAM), Integrated circuit technologies (Operational characteristic and parameters, TTL & COMS circuits, uses and comparisons, ECL, PMOS, NMOS and E^2CMOS circuits)

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Floyd, T. L., (2014), Digital Fundamentals, 11th Edition, Pearson
2) Holdsworth, B. & Woods, R. C., (2002), Digital system design, 4th Edition, Newnes Publications
3) Roth, C. H. & Kinney, L. L., (2014), Fundamentals of Logic Design, 7th Edition, Cengage Learning

Semester 2			
Course Code:	BECS 12451		
Course Name:	Digital Electronics Laboratory		
Credit Value:	1		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11431 Analogue Electronics Laboratory I		
Co-Requisites	BECS 12443 Digital Electronics		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	20

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- handle electronic components and equipment related to digital electronics
- design, assemble and test combinational and sequential circuits
- develop skills of writing technical reports based on analysis of experimental data

Course Content:

Characteristics of AND, OR, NAND, NOR, EX-OR, EX-NOR Logic gates, Combinational logic circuits, Adders, Flip-flops, Sequential circuits, Counters, Registers etc.

Teaching/Learning Methods:

10 lab sessions per semester (one 3hr laboratory session per week

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Lab reports 40, Attendance 20	Theory N/A	Practical 30	Other(specify) 10 for Oral presentation or Viva

References/Reading Materials:

1) Floyd, T. L., (2014), Digital Fundamentals, 11th Edition, Pearson
2) Holdsworth, B. & Woods, R. C., (2002), Digital system design, 4th Edition, Newnes Publications

Semester 2			
Course Code:	BECS 12462		
Course Name:	Mechanics & Properties of Materials		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	A/L Physics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate the understanding on fundamental concepts of physics in mechanics
- gain the skills in relevant applications and solving problems
- demonstrate the knowledge on fundamental concepts and basic principles that are related to the materials for electronics
- have the knowledge in latest progress in this field

Course Content:

Units and measurements. Coordinate systems, Scalars and vectors. The Force and Linear motion. Work and energy, Power. Conservation of energy and momentum. Gravitation. Circular motion and rotational dynamics; Torques and moments of inertia, Angular momentum, Periodic motion, Precession, Gyroscope, Rotating frames of reference, Inertial forces. Bond potentials, Valance charge, Crystal structures and defects. Ceramics for electronics. Semiconductor materials. Nanostructures and nanoelectronics. Organic electronics

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Giancoli, D. C., (2013), Physics: Principles with Applications, 7th Edition, Prentice Hall
2) Halliday D., Resnick, R. & Walker. J., (2010), Fundamentals of Physics, 9th Edition, John Wiley
3) Young, H. D. & Freedman, R. A., (2016), University Physics with Modern Physics, 14th Edition, Pearson
4) Sears, F. W., (1951), Mechanics, Heat, and Sound, Addison Wesley Co
5) Feynman, R. P., (1964), Feynman Lectures on Physics
6) Callister, W. D. & Rethwisch, D. G., (2014), Materials Science and Engineering: an introduction, 9th Edition, John Wiley & Sons
7) Smith, W. F. & Hashemi, J., (2010), Foundations of Materials Science and Engineering, 5th Edition, McGraw-Hill

Semester 2			
Course Code:	BECS 12623		
Course Name:	Calculus		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11613 Applied Algebra and Statistics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- determine the supremum and infimum of non-empty bounded sets
- apply algebra of limits and also formal definition in finding limits of sequences and functions of one variable, and compute definite integrals

- find limits, partial derivatives and extrema for functions of several variables and compute double integrals

Course Content:

Real numbers: Triangle inequality, Upper bound and lower bounds, Continuum property, Supremum and infimum of a set

Sequences: Limits, Bonded sequences, Monotone sequences, Algebra of limits, Sandwich theorem

Functions of one variable: Limits, Continuity, Differentiability, Intermediate value theorem, Taylor series, Using derivatives for approximations, L'Hôpital's rule, Anti-derivative, Definite integrals, Methods of integration

Functions of two variables: Surfaces, Partial derivatives, Gradient vectors, Directional derivatives, Applications of double integrals, Volume under a surface, Change the variable technique

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Ayres, J. F. & Mendelson, E., (2012), Calculus, 6th Edition, McGraw-Hill
2) Arora, S. & Malik, S. C., (1994), Mathematical Analysis, Wiley Eastern
3) Spiegel, M. R., (1974), Advanced Calculus, McGraw-Hill

Semester 2

Course Code:	BECS 12732		
Course Name:	Professional English		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 11712 Foundation Course in English		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- use social language in a range of situations
- effectively express viewpoints orally and in writing in a professional setting
- improve their grammar, vocabulary and conversation skills necessary to be successful in a professional environment
- comment and exchange ideas in a politically correct, polite manner

Course Content:

Greeting and small talk in a business context; Letter writing: cover letters, letters of excuse, requests, complaints, orders; Ethics, values and politically correct terms; Telephone etiquette; Netiquette; Idiomatic expressions; Preparing a CV; Presentation skills; Personal care and appearance; Interview skills

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (100%)	Final Assessment (N/A)		
Details: Assignment 90, Attendance 10	Theory N/A	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Galanes, G., & Brilhart, K., (1997), Communication in Groups: Application and Skills, McGraw-Hill
2) Longress, J. F., (1995), Human Behaviour in the Social Environment, Peacock Publishers
3) Saslow, J. & Ascher, A., (2011), Top Notch 2, 2nd Edition, Pearson

Semester 2

Course Code:	BECS 12742
Course Name:	Project Management and Financing
Credit Value:	2

Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- analyse and interpret qualitative and quantitative information
- undertake a project proposal and manage a mini project and demonstrate transferable skills and knowledge
- acquire competencies that help to assume predetermined responsibilities,
- use project management software packages effectively in project management

Course Content:

Uses the project life cycle as the organizational guideline and whole process of project management including purpose, principles, problems and challenges. Project management; Concepts, Techniques. Practices of project planning. Project initiation. Project implementation. Project monitoring and project termination. Use of project management software and their applications

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Group Report 20, Presentation 10, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Larson, E. W., Gray, C. F., (2011), Project Management: The Managerial Process. The McGraw-Hill Companies, Inc.
2) A Guide to the Project Management Body of Knowledge, (2013), PMBOK Guide 5th Edition, Project Management Institute (PIM)
3) Harvey, M., (2003), Project Management, 3rd Edition, Pearson Education
4) Samuel, J. M. & Jack, R. M., (2009), Project Management: A Managerial Approach, John Wiley& Sons Inc.

Semester 5			
Course Code:	BECS 21213		
Course Name:	Software Engineering		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 12243		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand the principles behind software engineering processes and the strengths and weaknesses of various software processes
- produce simple analyses, designs, implementations and test suites for small systems

Course Content:

Software and Software Engineering: Software processes, requirement engineering, system modeling, software prototyping, formal specification, architectural design, object-oriented design, user interface design, software testing, project management, managing people, software cost estimation, quality management, configuration management; Introduction to Ethics: Variety of ethical views, justice and social contract theory; professional conduct followed in the IT industry.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details:	Theory	Practical	Other(specify)

Quizzes 5, Assignment 25, Attendance 10	50	N/A	10 (Project)

References/Reading Materials:

1) Sommerville, I. (2015). Software engineering. 10th Edition. Pearson.
2) Pressman, R. S. (2014). Software engineering: a practitioner's approach. 8th Edition. McGraw-Hill Education.
3) Wiegers, K., Beatty, J. (2013). Software requirements. 3rd Edition. Microsoft Press.
4) Cohn, M. (2010). Succeeding with agile: software development using Scrum. 1st Edition. Addison-Wesley Professional.
5) Baase, S., Henry, T. M. (2017). A Gift of Fire: Social, Legal, and Ethical Issues for Computing Technology. 5th Edition. Pearson.

Semester 2			
Course Code:	BECS 21223		
Course Name:	Data Structures and Algorithms		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 12243		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- apply object-oriented programming, as a modern tool to solve practical computing problems
- identify basic data structures and algorithms
- demonstrate the ability to analyze, design, apply and use data structures and algorithms to solve practical problems and evaluate their solutions
- use complexity analysis to compare algorithm performances.

Course Content:

Data structure concepts; Arrays; Simple linked lists; Different implementations of lists; Stacks and queues; Sets; Binary-trees; Balanced trees; Heaps; Priority queues; Dictionaries/maps; Graphs; Introduction to complexity: Big or little O-notation; Algorithms: Recursion and backtracking, Sorting and searching, Hashing.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Individual and Group Projects, Student-centred discussions

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (30%)	Final Assessment (70%)		
Details:	Theory	Practical	Other(specify)
Quizzes 5, Assignment 15, Attendance 10	40	30	N/A

References/Reading Materials:

1) Lewis, J., DePasquale, P., Chase, J. (2016). Java Foundations: Introduction to Program Design and Data Structures. 4th Edition. Pearson.
2) Shaffer, C. A. (2011). Data Structures and Algorithm Analysis in Java. 3rd Edition. Dover Publications.
3) Weiss, M. A. (2013). Data structures & algorithm analysis in C++. 4th Edition. Pearson Education.
4) Lee, K. D., Hubbard, S. (2015). Data Structures and Algorithms with Python. Springer Publications.
5) Weiss, M. A. (2011). Data structures and algorithm analysis in Java. 3rd Edition. Pearson.
6) Carrano, F. M., Henry T. M. (2015). Data Structures and Abstractions with Java. 4th edition. Pearson.

Semester 3			
Course Code:	BECS 21413		
Course Name:	Analogue Electronics II (Operational Amplifiers)		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11413 Analogue Electronics I		
Co-Requisites	Analogue Electronics Laboratory II		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand the behaviour of ideal OP-AMPs
- understand the concepts and applications of operational amplifiers, and their uses in analogue circuits
- analyse and solve problems in OP-AMP based circuits
- design analogue computational circuits using OP-AMPs
- understand the operation of OP-AMP based power controlling circuits

Course Content:

Operational-amplifier characteristics, Typical performance of selected op-amp types, Non-ideal behaviour, Saturation, Frequency response, Slew rate. Basic uses of op-amp: Feedback-amplifiers (inverting, non-inverting & summing), Follower, Integrator, Differentiator, Scalar changer, Phase shifter, Filter, VC and CV converter, Function generators and signal conditioners. Other uses of op-amp: Comparator, Zero-crossing detector, Clipping, Clamping, Waveform generators and wave-shaping circuits, Precision rectifier, Schmitt triggers and multivibrator. Electronic analogue computation: Solution of differential equation, Time scaling and amplitude scaling of differential equation, Simulation of transfer function. Switching and amplifying circuits. Regulators: Basic series and shunt regulators, Series regulator with transistor and op-amp feedback, Current limiting circuit, Complete power supply

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details:	Theory	Practical	Other(specify)
Quizzes 5, Assignment 5, Attendance 10	80	N/A	N/A

References/Reading Materials:

1) Floyd, T. L., (2017), Electronic Devices, 10th Edition (Electron Flow Version), Prentice-Hall International
2) Clayton, G. & Winder, S., (2003), Operational Amplifiers, 5th Edition, Newnes Publications
3) Franco, S., (2015), Design with Operational Amplifiers and Analogue Integrated Circuits, 4th Edition, McGraw-Hill
4) Horowitz, P. & Hill, W., (2015), The art of electronics, 3rd Edition, Cambridge University Press
5) Huijsing, J., (2011), Operational Amplifiers: Theory and Design, 2nd Edition, Springer

Semester 3			
Course Code:	BECS 21422		
Course Name:	Electromagnetism		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11613 Applied Algebra & Statistics		
Co-Requisites	Analogue Electronics Laboratory II		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate basic mathematic skills needed to understand concepts in electromagnetism
- demonstrate the understanding on the fundamental concepts of electromagnetism
- use Maxwell equations to explain EM wave propagation
- ability of solving problems in electromagnetic applications

Course Content:

Electrostatics; Electrostatic Field, Divergence and Curl of **E**, Electrostatic Potential, Work and Energy in Electrostatics. Special Techniques for Calculating Potentials; Differential Form of Gauss's Theorem, Poisson's Equation, Laplace's Equation, Boundary Value Problems, Method of Images. Electric Multipoles. Maxwell's Equations in Electrostatics

Magnetostatics; Lorentz Force, Biot-Savart Law for Line-, Surface-, and Volume Currents, Divergence and Curl of **B**. Ampere's Circuital Law. Magnetic Vector Potential. Magnetic Fields of Toroids and Solenoids. Maxwell's Equations in Magnetostatics. Magnetic Materials; Paramagnetism, Diamagnetism, Ferromagnetism. Magnetisation

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:			
Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Sadiku, M. N. O., (2014), Elements of Electromagnetics, 6th Edition, Oxford University Press
2) Purcell, E. M.& Morin, D. J.,(2013), Electricity and Magnetism, 3rd Edition, Cambridge University Press
3) Hayt, W. & Buck, J., (2019), Engineering Electromagnetics, McGraw-Hill

Semester 3			
Course Code:	BECS 21431		
Course Name:	Analogue Electronics Laboratory II		
Credit Value:	1		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11431 Analogue Electronics Laboratory I		
Co-Requisites	BECS 21413 Analogue Electronics II & BECS 21422 Electromagnetism		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	50

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- use test & measuring instruments related to analogue electronics and electromagnetism
- demonstrate skills of designing electronic circuits with operational amplifiers
- perform experiments on related to the basics of electromagnetism
- writing technical reports by analysing experimental data

Course Content:

Experiments based on operational amplifier characteristics and applications. Basic laws of magnetism. Mutual Inductance, Transformers, Maximum power transfer theorem, Earth's magnetic field, Tangent galvanometer, Ballistic galvanometer

Teaching/Learning Methods:

10 lab sessions per semester (one 3hr laboratory session per week)

Assessment Strategy:			
Continuous Assessment (60%)	Final Assessment (40%)		
Details: Lab reports 40, Attendance 20	Theory N/A	Practical 30	Other(specify) 10 for Oral presentation or Viva

References/Reading Materials:

1) Floyd, T. L., (2017), Electronic Devices, 10th Edition (Electron Flow Version), Prentice-Hall International
2) Clayton, G. & Winder, S., (2003), Operational Amplifiers, 5th Edition, Newnes Publications
3) Franco, S., (2015), Design with Operational Amplifiers and Analogue Integrated Circuits, 4th Edition, McGraw-Hill
4) Purcell, E. M. & Morin, D. J., (2013), Electricity and Magnetism, 3rd Edition, Cambridge University Press

Semester 3			
Course Code:	BECS 21613		
Course Name:	Differential Equations, Integral Transforms and Numerical Methods		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	A/L Combined Mathematics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- distinguish linear and non-linear ordinary differential equations and solve non-linear first order and linear ordinary differential equations using appropriate methods
- develop mathematical models of some real-life systems or phenomenon from physical, sociological or economical problem
- solve the mathematical model and interpret the mathematical results back into the context of the original problem

Course Content:

First Order Linear Differential Equations: Formation of differential equations, Variable separable, Homogeneous, Exact equations, Integration factor method, Bernoulli equations
First Order Non-Linear Differential Equations: Riccati, Clairaut types, Euler's equation
Linear differential equations of higher degree: Equations with constant coefficients, Operator methods
Systems of linear equations with constant coefficients
Series solutions of ordinary differential equations
Introduction to first order partial differential equations
Integral Transforms: Laplace Transforms, Fourier Transforms
Numerical Solution of equations with one variable: Numerical solution of nonlinear equations
Numerical Solution of System of Linear Equations (Direct and Iterative Methods): Gaussian eliminations with partial pivoting, Ill conditioning, Jacobi and Gauss-Seidel iterative methods
Least square curve fitting
Numerical Integration: Trapezoidal, Simpson quadratic formulae
Numerical Solutions of Ordinary Differential Equations: Explicit and Implicit numerical schemes, Euler's and Runge-Kutta methods

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Raisinghania, M. D., (1991), Advanced Differential Equations, S. Chands
2) Mondal, C. R., (2003), Ordinary Differential Equations, Prentice Hall
3) Pinsky, M. A., (2003), Partial Differential Equations and Boundary Value Problems with Application, Waveland Press
4) Burden, R. L. & Faireu, J. D., (1993), Numerical Analysis, 5th Edition, PWS-KENT

Semester 3			
Course Code:	BECS 21712		
Course Name:	English in Today's World		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 12732 Professional English		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to understand:

- basic terminology of Language & Culture, Economics, Geography, History, Archaeology, Mass Communication, Fine Arts etc.
- library Skills
- read & comprehend passages from textbooks: Commerce, Management, Human Resources, Computers, Economics, Science, Medicine
- debate/Discuss contemporary issues
- listen to & comprehend short lectures, conversations, news broadcasts, songs, sports commentaries etc.
- use 'politically correct' terminology [i.e. language not derogatory of minorities, inclusive of women, the disabled]
- letter writing in professional context

Course Content:

Language and Culture: Language change, Views on language

Sri Lankan English: The features of Sri Lankan English, The standard variety, The non- standard variety Differences between Colloquial English, Scientific Technical English, Formal English, and PowerPoint English
Current Issues: Social issues, Expressing critical views on current issues
Politically Correct Terms: Talking issues using politically correct terminology
Writing Letters: Writing letters of excuse at University, Writing letters of request at University
Leisure: Discussing leisure activities, Trends in leisure
Criticizing Language Use: Critically analysing language samples, Looking at meaning behind words

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions, Guest lectures

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Assignment 30, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:
1) Gunesekera, M., (2005), The Post-Colonial Identity of Sri Lankan English, Katha Publishers
2) Heyer, S., (1996), True Stories in the News: A beginning Reader, 3rd Edition, Pearson Publishes

Semester 3			
Course Code:	BECS 21722		
Course Name:	Organizational Behaviour		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- demonstrate a substantive knowledge of key theories relating to organizational behaviour
- apply knowledge and understanding of the concepts and principles of the area of study
- construct and sustain arguments to diagnosis and problem solving by applying the learned concepts to given situations
- engage in independent learning using scholarly reviews and secondary sources of information
- exercise leadership in the professional environment/work place

Course Content:
Introduction to organizational behaviour. Organizational behaviour and management. Personality and Learning. Perception. Attribution and judgment of others. Values. Attitudes and work behaviour. Work motivation in practice. Groups and teams. Leadership. Managing work conflict and stress. Organizational culture

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Assignment 20, Attendance 10	Theory 70	Practical N/A	Other(specify) N/A

References/Reading Materials:
1) Luthans, F., (2011), Organizational Behaviour, 12th Edition, McGraw-Hill Inc.
2) Levy, P. E., (2015), Industrial / Organizational Psychology: Understanding the work place, 5th Edition, worth Publishers
3) Robbins, S. P., Judge, T. A., (2013), Organizational Behaviour, 15th Edition, Prentice Hall
4) Robbins, S. P., Judge, T., (2016), Essentials of Organizational Behaviour, 13th Edition, Prentice Hall

Semester 3	
Course Code:	BECS 22233
Course Name:	Computer Architecture and Operating Systems
Credit Value:	3
Compulsory/Optional	Compulsory

Pre-Requisites	BECS 11212, BECS 12443		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	40	15	95

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe computer architecture concepts and mechanisms related to the design of modern processors, memories, and networks and explain how these concepts and mechanisms interact
- apply this understanding to new computer architecture design problems within the context of balancing application requirements against technology constraints
- describe the memory management and its associated features
- explain the role and characteristics of modern operating systems
- describe memory management, file management and storage management
- describe similarities and differences between modern operating systems
- implement basic OS algorithms

Course Content:

Introduction to computer hardware and technologies: MIPS ISA, Fundamental concepts ISA, ISA trade-offs, More ISA Trade-offs and single-cycle microarchitectures, Multi-cycle microarchitectures, Microprogrammed microarchitectures, Microprogramming and pipelined microarchitectures, Pipelining and related Issues, Data and control dependence handling in pipelined microarchitectures, Control flow handling, Control flow and exceptions, Out-of-order execution, Approaches to concurrency (OoO, Dataflow, Vector, VLIW), Approaches to concurrency (SIMD and VLIW), Memory hierarchy, Caches, Main memory, Memory scheduling, Virtual memory, Tolerating memory latency, Runahead and multiprocessing, Multiprocessor correctness and cache coherence, Interconnects.

Introduction to the concepts and design of multi-programmed operating systems; Typical topics include: historical perspectives; Sequential processes; Concurrent processes (mutual exclusion and synchronization); Processor management, Deadlock prevention, avoidance and detection; Memory management and paging, Virtual memory; Secondary store management; CPU/Disk scheduling; File management; Resource protection and security; Case studies with both Unix(Linux) or Windows.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details:	Theory	Practical	Other(specify)
Quizzes 5, Assignment 25, Attendance 10	60	N/A	N/A

References/Reading Materials:

1) Comer, D. E. (2004). Essentials of Computer Architecture. Pearson.
2) Stallings, W. (2011). Computer Organization and Architecture: Designing for Performance. 10th Edition. Pearson.
3) Hennessy, J. L., Patterson, D. A. (2011). Computer architecture: a quantitative approach. 5th Edition. Morgan Kaufmann.
4) Stallings, W. (2014). Operating Systems: Internals and Design Principles. 8th Edition. Pearson.
5) Silberschatz, A., Gagne, G., Galvin, P. B. (2018). Operating System Concepts. 10th Edition. Wiley.

Semester 3			
Course Code:	BECS 22243		
Course Name:	Database Management Systems		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe various logical database architectures
- design & develop databases using relational model and manipulate data
- use databases in software solutions

- apply theories behind various database models and query languages in practical scenarios
- discuss security and integrity policies relating to databases.

Course Content:

Introduction to database systems: Database system concepts and architecture, Three tire architecture and mapping; Data Modelling: Entity-Relationship (ER) model and Enhanced Entity-Relationship (EER) model; Relational model: Introduction to the relational model, Relational constraints, Normalization approach for relational database design (first, second, third and BCNF normal forms), Advantages and disadvantages of the normalization approach; Logical database design: ER to relational mapping and EER to relational mapping, Data manipulation: Relational algebra and relational calculus, Data manipulation using SQL, Security and integrity in databases; Physical database design: Storing data and primary file organization, File organization and indexes (primary, secondary, clustering and multilevel indexes).

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 40	Practical 20	Other(specify) N/A

References/Reading Materials:

1) Ricardo, C. M., Urban, S. D. (2015). Databases Illuminated. 3rd Edition. Jones & Bartlett Publishers.
2) Elmasri, R., Navathe S.B. (2017). Fundamentals of database systems. 7th Edition. Pearson Education India.
3) Hoffer, J. A., Venkataraman, R., Topi. H., (2019), Modern Database Management, 13th Edition Pearson.
4) Ramakrishnan, R., Gehrke, J. (2002). Database management systems. 3rd Edition. McGraw Hill.
5) Molinaro, A. (2005). SQL Cookbook: Query Solutions and Techniques for Database Developers. O'Reilly Media, Inc..

Semester 6

Course Code:	BECS 22253		
Course Name:	Web & Internet Technologies		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 12233, BECS 12243, BECS 22243		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe basic concepts of web and the internet technologies
- use client-side technologies for building, usable, accessible, standard compliant web pages
- use server-side technologies for building secure database driven web applications
- describe and critically discuss the design, engineering, legal, social, ethical and professional issues and considerations involved in web application development.

Course Content:

Overview of the Internet; Web technologies: Standard client side technologies including HTML/ XHTML, CSS, JavaScript and related libraries, DOM, cookies. Web servers and server-side technologies including Apache, PHP, session state and database connectivity using MySQL; Issues and considerations in web application development: standards, maintenance, efficiency, stability, usability, accessibility, law, security and privacy, emerging trends and best practices.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 40	Practical 20	Other(specify) N/A

References/Reading Materials:

1) Connolly, R., Hoar, R. (2015). Fundamentals of Web Development. 2nd Edition. Pearson.

2) Deitel, P. J., Deitel, H. M., Deitel, A. (2011). Internet & World Wide Web How to Program. 5th Edition. Pearson.
3) Welling, L., Thomson, L. (2016). PHP and MySQL Web Development. 5th Edition. Addison-Wesley.
4) Jackson, J. C. (2006). Web Technologies: A Computer Science Perspective. Prentice Hall.
5) Scobet P., Lingras, P. (2016). Web Programming and Internet Technologies: An E-Commerce Approach. 2nd Edition. Jones & Bartlett Learning.

Semester 4			
Course Code:	BECS 22443		
Course Name:	Measurements and Instrumentation		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	All previous Electronics Compulsory course modules		
Co-Requisites	BECS 22451 Measurements and Instrumentation Laboratory		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- differentiate between sensors and transducers
- describe characteristics and operational principles of electronic measuring instruments and sensors
- analyse measuring errors and improve the accuracy of measurements
- design and implement simple measuring instruments
- demonstrate knowledge of the operation of electronic components in modern data acquisition systems

Course Content:

Interfacing between logic families, Driving digital logic from comparators and op-amps, Bridge circuits (non-linearity/sensitivity, lead resistance error, signal conditioning electronics), Strain gages (Pressure, Flow, Strain measurement, Electronic circuit design), High impedance sensors and measuring electronics (Photodiodes, Humidity monitors, Chemical sensors etc.), Temperature sensors and measuring electronics (Thermocouple, RTD, Thermistors, Semiconductor temperature sensors), Special sensors, Signal conditioning (noise analysis and noise elimination techniques), Active filter design, Shaping methods, Trigger techniques, Discriminators, Digital to analogue converters (DACs), Scaled current sources, Generating voltages from current output DACs, Time-domain (averaging) DACs, Multiplying DACs, Analogue to digital converters (ADCs), Parallel encoder, Successive-approximation ADC, Voltage-to-frequency conversion, Single-slope integration, Charge-balancing technique, Dual-slope Integration, Delta-sigma converters, Switched-capacitor ADC, Some A/D Conversion examples, Decoders and encoders, Multiplexing, Bandwidth-narrowing techniques, Signal-to-noise computation, Signal averaging, Spectrum analysis and Fourier transforms

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Floyd, T. L., (2017), Electronic Devices, 10th Edition (Electron Flow Version), Prentice-Hall International
2) Floyd, T. L., (2014), Digital Fundamentals, 11th Edition, Pearson
3) Fraden, J., (2016), Handbook of Modern Sensors - Physics, Design, and Applications, 5th Edition, Springer
4) Northrop, R. B., (2005), Introduction to Instrumentation and Measurements, 2nd Edition, CRC Press
5) Horowitz, P. & Hill, W., (2015), The art of electronics, 3rd Edition, Cambridge University Press

Semester 4	
Course Code:	BECS 22451
Course Name:	Measurements and Instrumentation Laboratory
Credit Value:	1
Compulsory/Optional	Compulsory
Pre-Requisites	All previous Laboratory Classes

Co-Requisites	BECS 22443 Measurements and Instrumentation		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	20

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate skills on designing and implementing sensors and instrumentation systems
- analyse experimental data and write technical reports

Course Content:

Experiments based on comparators, Sensors, ADCs, DACs, Amplifiers, Pulse shapers, Encoders, Decoders, Filters, etc.

Teaching/Learning Methods:

10 lab sessions per semester (one 3hr laboratory session per week)

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Lab reports 40, Attendance 20	Theory N/A	Practical 30	Other(specify) 10 for Oral presentation or Viva

References/Reading Materials:

1) Floyd, T. L., (2017), Electronic Devices, 10th Edition (Electron Flow Version), Prentice-Hall International
2) Floyd, T. L., (2014), Digital Fundamentals, 11th Edition, Pearson
3) Fraden, J., (2016), Handbook of Modern Sensors - Physics, Design, and Applications, 5th Edition, Springer
4) Northrop, R. B., (2005), Introduction to Instrumentation and Measurements, 2nd Edition, CRC Press
5) Horowitz, P. & Hill, W., (2015), The art of electronics, 3rd Edition, Cambridge University Press

Semester 4			
Course Code:	BECS 22462		
Course Name:	Signals and Systems		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21613 Differential Equations, Integral Transforms and Numerical Methods		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand basic concepts of signals and systems
- analyse linear time invariant system responses in time domain using the convolution
- analyse continuous time signals and systems in the frequency domain using the Fourier Transform
- determine the frequency spectrum of periodic and aperiodic signals using Fourier series and Fourier transform
- analyse continuous-time signals and system responses using the concepts of transfer function representation by use of Laplace and inverse Laplace transforms
- analyse discrete-time signals and system responses using the concepts of transfer function representation by use of Z and Inverse-Z transforms
- use of MATLAB to simulate and analyse signals and systems

Course Content:

Review of basic MATLAB operations, Signals and systems; Discrete-time signals, Continuous-time signals, Linearity and time invariance, Impulse and step responses, Time-domain analysis of linear time-invariant (LTI) continuous-time (CT) and discrete-time (DT) systems. System frequency response, Frequency-domain representations, Fourier series and transforms, Fourier representation of signals, Frequency-domain analysis of CT/DT signals and LTI systems. Laplace and inverse Laplace transforms, Z and inverse Z transforms, Analysis of linear time-invariant (LTI) systems, Sampling, Sampling theorem, Modulation, Convolution, Filtering and signal distortion. Time/frequency sampling and interpolation, Continuous-discrete-time signal conversion and quantization, Discrete-time signal processing, Communication system applications, Use of MATLAB for signal processing and communication applications

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions, MATLAB Simulation Lab class

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Roberts, M. J., (2008), Fundamentals of Signals and Systems, 1st Edition, McGraw-Hill
2) Haykin, S.B., & Veen. V., (2003), Signal and Systems, 2nd Edition, John Wiley & Sons
3) Oppenhiem, A. V. & Willsky, A. S., (1996), Signals and systems, 2nd Edition, Prentice Hall
4) Lathi B. P., (2004), Linear Systems and Signals, Oxford university press, 2nd Edition
5) Phillips, C. L., Parr, J.M., & Riskin E. A., (2014), Signals, Systems, and Transforms, 5th Edition, Pearson
6) Lindner, D. K., (1999), Introduction to Signals and Systems, 1st Edition, McGraw-Hill
7) Kamen, E. & Heck, B., (2007), Fundamentals of Signals and Systems Using the Web and MATLAB, 3rd Edition, Prentice Hall
8) Palm, W., (2005), Introduction to MATLAB 7 for Engineers, 2nd Edition, McGraw-Hill
9) Gilat, A., (2014), MATLAB: An Introduction with Applications, 5th Edition, Wiley
10) Proakis, J. G., Salehi, M.,& Bauch, G., (2013), Contemporary Communication Systems Using MATLAB, 3rd Edition, Cengage Learning

Semester 4			
Course Code:	BECS 22623		
Course Name:	Implementation of Numerical Methods using Appropriate Software		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21613 Differential Equations, Integral Transforms and Numerical Methods		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- develop and understand commonly used numerical methods with their limitations for solving real world problems
- develop structured problem solving techniques, a knowledge of programming concepts and the ability to write programs

Course Content:
Introduction to MATLAB: MATLAB basics, Matrix calculations and Plotting, Script M-files, Function files, Input and output, If Statements, Loops
Programming of Numerical Techniques: Roots finding and optimization, interpolation and extrapolation, linear and nonlinear regression, Numerical Integration, Solving ordinary differential equations, Solving linear systems

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Vanloan, C. F., (2000), Introduction to scientific computing: a matrix-vector approach using MATLAB, Prentice Hall
2) Chapman, S. J., (2015), MATLAB Programming for Engineers, 5th Edition, Cengage Learning
3) Chapra, S. C., (2012), Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata McGraw-Hill

Semester 4	
Course Code:	BECS 22811
Course Name:	Creative Design Project I

Credit Value:	1		
Compulsory/Optional	Compulsory		
Pre-Requisites	All Compulsory course units		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	70

Course Aim/Intended Learning Outcomes:

The aim of this course is to encourage students to get familiar with the process of scientific problem solving through a set project. Students can choose their projects from either Computer Science or Electronics discipline. At the completion of this course students will be able to:

- collaborate as a team to produce a practical design meeting the given objectives using relevant concepts learnt during previous courses
- analyse, design, simulate and build simple electronic circuits
- write a project plan, document progress in detail, and conduct design reviews
- convince others via effective communication, both orally and in writing
- improve technical abilities

Course Content:

This course is conducted throughout the second semester of level 2. This is a group project and each group will include a group of 3 to 5 students. They must carry out a given design project over the semester. The students are expected to apply the knowledge and skills acquired in the first and second year of their curriculum in order to implement the design produced. They are expected to develop skills in group and team management while carrying out their task. They have to work within a specified time scale

Teaching/Learning Methods:

PODBL (Project Oriented Design Based Learning) method will be utilized

Assessment Strategy:

Continuous Assessment (80%)	Final Assessment (20%)		
Details: Project proposal 10, Project Progress Presentation 10, Project Report 40, Attendance 20	Theory N/A	Practical N/A	Other(specify) Oral Presentation 10 Demonstration 10

References/Reading Materials:

1) Ford, R. & Coulston, C., (2005), Design for electrical and computer engineers: Theory, concepts, and practice, 1st Edition, McGraw-Hill
2) Other material as appropriate depending on the given objectives

Semester 4			
Course Code:	BECS 22732		
Course Name:	Marketing Fundamentals		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate knowledge and understanding of concepts and principles of marketing
- develop initial arguments and make some judgements in accordance with basic theories and concepts of marketing
- demonstrate qualities and transferable skills including ICT skills necessary for employment in the area of marketing
- identify the importance of Customer Relationship Management, Life time value of the customer and ethics in marketing for technological products

Course Content:

Introduction to marketing. The products marketing, Micro and macro environments, Understanding the institution. Customers and products, Customer segmentation, Targeting and positioning, Managing for profit; Customer value, Product pricing, Product development and distribution, Communicating with customers, Customer relationship management, Brand management, Developing strategies and addressing issues in marketing, Ethical issues in marketing

Teaching/Learning Methods: Combination of Lectures, Tutorial discussions, Student-centred discussions			
Assessment Strategy:			
Continuous Assessment (30%)	Final Assessment (70%)		
Details: Report 10, Presentation 10, Attendance 10	Theory 70	Practical N/A	Other(specify) N/A
References/Reading Materials: 1) Venkatesh, K., (2012), Marketing of Information Technology, McGraw-Hill Education, India 2) Kotler, P. & Armstrong, G., (2012), Principles of Marketing, 14th Edition, Pearson Prentice-Hall Journal articles 3) Parasuraman, A., Scholarly articles of Dimension of Service Marketing			

Semester 6			
Course Code:	BECS 31213		
Course Name:	Enterprise Software Design and Architecture		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 21223, BECS 22243		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	NA	105
Course Aim/Intended Learning Outcomes: At the completion of this course students will be able to: ➢ explain the concept of Enterprise Software Architecture ➢ apply different architectural styles to solve different business models ➢ analyze and design appropriate enterprise applications ➢ identify how design patterns will resolve subtle coding issues.			
Course Content: Introduction to Enterprise Applications: web, standalone and cloud applications; Software System Architecture; Architecture Views and Decomposition; Architecture Styles; Middleware, strategies for data Processing; Service-Oriented-Architecture; Resource-Oriented Architecture; Domain-Driven Architecture; Event-Driven Architecture; Design Patterns; Micro services; RESTful Architecture; Best practices in application development; Web Services: Web Services Frameworks and their Performance, Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL), Web Services Security.			
Teaching/Learning Methods: Combination of Lectures, Tutorial discussions, Individual and group projects, Student-centred discussions			
Assessment Strategy:			
Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A
References/Reading Materials: 1) Taylor, R. N., Medvidovic N., Dashofy, E. (2009). Software Architecture: Foundations, Theory, and Practice. 1st Edition. Wiley. 2) Gorton, I. (2006). Essential software architecture. Springer Science & Business Media. 3) Brooks Jr, F. P. (2010). The design of design: Essays from a computer scientist. Pearson Education. 4) Gamma, E., Helm, R., Johnson, R., Vlissides, J. (1994). Design Patterns: Elements of Reusable Object-Oriented Software. 1st Edition. Addison-Wesley. 5) Freeman, E., Robson, E., Bates, B., Sierra, K. (2004). Head First Design Patterns. O'Reilly Media Inc.			

Semester 5	
Course Code:	BECS 31223
Course Name:	Cyber Security and Forensics
Credit Value:	3
Compulsory/Optional	Compulsory
Pre-Requisites	BECS 12233
Co-Requisites	N/A

Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- appreciate the need for good security management, and identify information security threats and counter measures
- demonstrate understanding of fundamentals of cryptography
- acquire background for providing security for slandered network, web and e-commerce applications
- gain hands-on experience with tools and programming techniques for security
- explain the principles of computer forensics, ethical, legal issues and forensic standards
- investigate and analyse cybercrime

Course Content:

Introduction to general issues in IT security, Understanding the threats, Formalisms, Policies, Introduction to cryptography and concepts, Security systems, Wired and wireless network security, File security, Software security, Web security, Virus/malware guards and their concepts, security threats and countermeasures, email security, firewalls, intrusion detection techniques, legal and ethical issues

Forensics: computer forensics principles, relationship between network forensic analysis and network security technologies, computer forensics tools, network security incidents and responses, cybercrime investigation and analysis, ethics and legal issues, forensics standards, requirement analysis

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Stallings, W., (2016), Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson
2) Nelson, B., Philips, A., Enfinger, F., & Steuart, C., (2015), Guide to Computer Forensics and Investigations, 5th Edition, Course Technology
3) Casey, E., (2011), Digital evidence and computer crime: Forensic science, computers, and the internet, 3rd Edition, Academic press
4) Stallings, W. (2018). Effective Cybersecurity: A Guide to Using Best Practices and Standards. 1st Edition. Addison-Wesley Professional.
5) Singer, P. W., Friedman, A. (2014). Cybersecurity: What everyone needs to know. 1st Edition. OUP USA.
6) Moschovitis, C. (2018). Cybersecurity Program Development for Business: The Essential Planning Guide. 1st Edition. John Wiley & Sons.
7) Pfleeger, C. P., Pfleeger, S. L., Margulies, J. (2015). 5th Edition. Security in computing. Prentice Hall.
8) Schneier, B. (2015). Applied cryptography: protocols, algorithms, and source code in C. 20th Anniversary Edition. John Wiley & Sons.

Semester 5			
Course Code:	BECS 31412		
Course Name:	Microcontrollers and Embedded Electronics		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	All previous Compulsory courses		
Co-Requisites	BECS 31421 Microcontrollers and Embedded Electronics Laboratory		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- explain the basic concepts related to microcontrollers, microprocessors and embedded systems
- understand the different types of microcontrollers
- design and implement microcontroller based applications

Course Content:
What is an embedded system?, Microprocessor vs. microcontroller, Microcontroller families, PIC microcontrollers, microcontroller architecture overview, Parallel port interface, Power supply, Clock oscillator, Assembly language programming, Parameter passing, Global variable, Local variable, Interrupt handling, Introduction to development environment, Serial port, Universal synchronous/asynchronous receiver/transmitter (USART), Data acquisition and manipulation, System C for microcontroller programming, Queue management, Resource management, Real world application design examples, DC motor control, Automation with microcontrollers, Brief introduction to Arduino & Raspberry pi, PIC vs. Arduino

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Wilmshurst, T., (2009), Designing Embedded Systems with PIC Microcontrollers, Principles and Applications, 2nd Edition, Newnes
2) Valvano, J. W., (2012), Embedded Microcomputer Systems: Real Time Interfacing, 3rd Edition, CL Engineering
3) Mazidi, M. A., Mazidi, J. G., & McKinlay, R. D., (2007), The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2nd Edition, Pearson
4) Lipovski, G. J. & Irwin, J. D., (2000), Embedded Microcontroller Interfacing for M COMPULSORY Systems, 1st Edition, Academic Press

Semester 5			
Course Code:	BECS 31421		
Course Name:	Microcontrollers and Embedded Electronics Laboratory		
Credit Value:	1		
Compulsory/Optional	Compulsory		
Pre-Requisites	All Electronics Laboratory classes of Level 1 & 2		
Co-Requisites	BECS 31412 Microcontrollers and Embedded Electronics		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	20

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- understand embedded systems using modular design and abstraction
- write programs using system C for selected microcontrollers
- build and test circuits with switches, LEDs, resistors, potentiometers, and liquid crystal displays
- synchronizing hardware and software input/output with switches, lights, sound, sensors, motors, and liquid crystal displays
- debug using oscilloscopes, logic analysers, and software instrumentation
- design and implement microcontroller based embedded electronics circuits
- use PIC, Arduino & Raspberry Pi for designing small scale embedded applications

Course Content:
Design and implementation of microcontroller based embedded electronics applications., PIC microcontrollers, Working with I/O pins of a microcontroller, Interfacing with LCD/ 7-segment displays, Connecting input devices, Serial communication, DAC AND ADC implementation, Industrial motor controlling (DC, Stepper, Servo and shaft-speed encoders), Interfacing different sensors with microcontroller, Several example application will be developed during lab sessions.

Teaching/Learning Methods:
10 lab sessions per semester (one 3hr laboratory session per week)

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Lab reports 40, Attendance 20	Theory N/A	Practical 30	Other(specify) 10 for Oral presentation or Viva

References/Reading Materials:

1) Wilmshurst, T., (2009), Designing Embedded Systems with PIC Microcontrollers, Principles and Applications, 2nd Edition, Newnes
2) Valvano, J. W., (2012), Embedded Microcomputer Systems: Real Time Interfacing, 3rd Edition, CL Engineering

Semester 5			
Course Code:	BECS 31433		
Course Name:	Communication Systems		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21413 Analogue Electronics II, BECS 21422 Electromagnetism, BECS 22462 Signals & Systems		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe the basic concepts and issues related to communication systems
- explain different types of analogue modulation techniques (Amplitude Modulation (AM), Frequency Modulation (FM) and Phase Modulation (PM))
- understand the fundamentals for analysis the performance of communication systems
- understand concepts of a digital communication system (Pulse Code Modulation (PCM)).

Course Content:

Introduction to communication systems; Network topologies, Types of communication channels, Bandwidth and filtering, Wave propagation, Modulation, Transmission, Multiplexing, Signal transmission, Baseband transmission, Frequency division multiplexing (FDM), Time division multiplexing (TDM), Linear modulation: Amplitude modulation(AM); Baseband vs. bandpass communications, Double sideband and double-sideband suppressed carrier, Asymmetric sideband signals: Single sideband and vestigial sideband, Performance analysis in noise, Carrier acquisition, Phase locked loops, Angle modulation; Phase and frequency modulation, Generation and demodulation of FM signals, Pre-emphasis and de-emphasis in angle-modulated systems, FM receivers, Radio and TV broadcasting, AM and FM broadcast technical standards, Sampling theorem: Nyquist rate, Ideal sampling and reconstruction, Practical sampling and reconstruction, Practical issues, Pulse amplitude modulation (PAM), Quantization, Pulse code modulation (PCM); Sampling, Non-uniform quantization and encoding, Bandwidth and noise considerations in PCM, Differential PCM, Delta modulation and linear predictive coding, PAM signals and power spectra, Line codes and spectra, Geometric space representation of signals and noise, Performance analysis in AWGN channels: Optimum detectors for binary polar signalling and general binary signalling, Space analysis of optimum detection

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Couch, L. W., (2013), Digital and Analogue Communication Systems, 8th Edition, Pearson
2) Couch, L. W., (2013), Digital and Analogue Communication Systems, 8th Edition, Pearson
3) Proakis, J. G.& Salehi, M., (2002), Communication Systems Engineering, 2nd Edition, Prentice-Hall
4) Lathi, B. P., (2009), Modern Digital and Analogue Communication Systems, 4th Edition, Oxford University Press
5) Haykin, S. & Moher, M., (2010), Communication Systems, 5th Edition, John Wiley

Semester 5	
Course Code:	BECS 31443
Course Name:	Control Systems Design
Credit Value:	3
Compulsory/Optional	Compulsory
Pre-Requisites	BECS 22462 Signals and Systems

Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	39	6 (Simulation)	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate the basic knowledge related to control system analysis
- perform time and frequency domain analysis of dynamical systems
- explain the performance specifications of control systems
- have a clear understanding on controller design process
- demonstrate the skills and techniques required for control system design

Course Content:

Introduction to control systems, System modelling, Block diagram and signal flow diagram, State variable, Open and close loop systems, Stability analysis, Time domain analysis. Performance of feedback control systems, Root-locus technique, Frequency domain analysis, Relative stability and design specifications, PID control

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Ogata, K., (2010), Modern Control Engineering, 5th Edition, Prentice-Hall
2) Dorf, R. C.& Bishop, R. H., (2017), Modern Control Systems, 13th Edition, Pearson
3) Kuo, B. C. & Golnaraghi, F., (2010), Automatic Control Systems, 9th Edition, John Wiley

Semester 5			
Course Code:	BECS 31712		
Course Name:	Technical Communication		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	All three previous English course modules		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate analytical comprehension skills in reading and listening
- improve communication skills as a successful employee
- demonstrate competency in the preparation of a technical report applying standard conventions of structure, layout and style
- prepare and defend a technical oral presentation recognizing the need for constructive criticism

Course Content:

Communication and its importance: An introduction; Listening and reading skills: Receiving, interpreting and responding to messages; Active and focused listening; Pre-reading, inferencing, skimming and scanning; Writing skills: academic/scientific writing; describing processes; Writing explanations and arguments; Summarizing; Mechanics of writing; Speaking skills: Debating skills/impromptu speeches; Presentation skills; Critical thinking in small groups; problem solving skills; perspectives on leadership

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions, Guest lectures, Workshops

Assessment Strategy:

Continuous Assessment (50%)	Final Assessment (50%)		
Details: Quizzes 5,, Assignment 35, Attendance 10	Theory 50	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Gerson, S. J. & Gerson, S. M., (2005), Technical writing: Process and Product, 5th Edition, Prentice Hall

2) Galanes, G. & Brilhart, K., (1997), Communication in Groups: Application and Skills. Missouri: McGraw-Hill
3) Longress, J. F., (2000), Human Behaviour in the Social Environment, 3rd Edition, Brooks Cole

Semester 5			
Course Code:	BECS 31722		
Course Name:	Introduction to Entrepreneurship		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- identify the notion of entrepreneurship and its significance
- identify the entrepreneurial process
- examine financial analysis for entrepreneurial ventures
- explain entrepreneurship in a Sri Lankan perspective

Course Content:
Decision to become an entrepreneur, Recognizing opportunities and generating ideas, Feasibility analysis, Industry and competitor analysis, Writing a business Plan, Developing an effective business model

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Business Plan Development 20, Presentation 10, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:
1) Barringer, B. R. & Ireland, R. D., (2008), Entrepreneurship: Successfully Launching New Ventures, 4th Edition, Prentice Hall
2) David, H. H., (2005), Entrepreneurship: New Venture Creation, Prentice-Hall
3) Hisrich, R., Peters, M. & Shepherd, D., (2006), Entrepreneurship, 6th Edition, McGraw-Hill
4) Kuratko, D. F. & Hodgetts, R. M., (2004), Entrepreneurship: Theory, Process and Practice, 6th Edition, Thomson
5) Timmons, J. A. & Spinelli, S., (2003), New Venture Creation - Entrepreneurship for the 21st Century. 8th Edition, New York: Irwin/McGraw-Hill

Semester 5			
Course Code:	BECS 31732		
Course Name:	Legal Environment of Business		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- familiar with basic legal principles, rules, regulations and acts relating to business environment
- minimize and avoid litigations in connection with the business
- apply the knowledge learnt to solve problems in simple situations

Course Content:
Introduction to commercial law. Legal system and the court system of Sri Lanka. The law of contract. The law of agency. Law of partnership. Sale of goods contracts. Insurance law. Lease and hire purchase. Current developments of commercial law in Sri Lanka

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Assignment 20, Attendance 10	Theory 70	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Bangia-Law of Contracts
2) Harsha, C., (2006), Intellectual Property Law of Sri Lanka
3) Cooray, L. J. M, (1972), An Introduction to The Legal System of Sri Lanka, 2nd Edition, Lake House Investments
4) Wickrema, W., Text Book of Commercial Law (Business Law), Postgraduate Institute of Management
5) Weeramantry, C. G., The Law of Contracts-relevant chapters
6) Relevant cases and Acts

Semester 6

Course Code:	BECS 32232		
Course Name:	Human Computer Interaction		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21213, BECS 22253		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	NA	70

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- describe how interface design practices and methods can be integrated with user centered principles and methods now being employed
- identify current trends in HCI research
- discuss the nature of the HCI design process
- apply an integrated perspective to the design process
- recognize the difficulties and pitfalls of translating theory and principles derived from research findings into practical advice on user-centered design
- apply metaphorical reasoning and conceptual models to user interface design
- express strategies for improving web site usability
- describe the major aspects of usability engineering
- apply usability and design principles to the evaluation of current interfaces.

Course Content:
Fundamentals of HCI (theories, models, paradigms, usability studies and controlled experimentation); Interaction design basics; HCI in the software process: Design and implementation, Evaluation of user interfaces, universal design and user support; Current trends in HCI research; Ubiquitous and pervasive computing; Human factors that affect the development of software, and design of user interfaces for interactive systems.

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (45%)	Final Assessment (55%)		
Details: Quizzes 5, Assignment 30, Attendance 10	Theory 55	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Sharp, H., Preece, J., Rogers, Y. (2019). Interaction Design: Beyond Human-Computer Interaction. 5th Edition. Wiley.
2) Shneiderman, B., Plaisant, C., Cohen, M., Jacobs, S., Elmqvist, N. (2016). Designing the user interface: strategies for effective human-computer interaction. 6th Edition. Pearson.
3) Dix, A., Finlay, J. E., Abowd, G. D., Beale, R. (2003). Human-Computer Interaction. 3rd Edition. Pearson.
4) Platt, D. (2016). The Joy of UX: User Experience and interactive design for developers. 1st Edition. Addison-Wesley Professional.

Semester 6			
Course Code:	BECS 32242		
Course Name:	Visual Programming		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21213, BECS 22243		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	NA	90	10

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- apply the concepts of visual programming and algorithm design
- use appropriate controls and events to develop user-friendly graphical interfaces
- use available classes and technologies to access database through graphical user interfaces
- design and develop stand-alone and web-based software applications for real-world problems.

Course Content:

Introduction to Visual Programming: A brief history and types of programming languages, use of an Integrated Development Environment, basic language facilities; events, errors and exceptions; Facilities for building GUI interfaces: Form design, Uses of forms, Controls and control properties, Design of forms; Event driven programming: Introduction to basic control objects, Branching, Control loops, Procedures and functions, interacting with the user, stream-based file I/O, Arrays, Database connectivity, connecting through ODBC, Introduction to Threads, Debugging and Testing; Querying the Database: Query by example, Query by form, Use of SQL commands; Reports: Development of a variety of reports including tabular, group totals, sub totals and other standard reports; Introduction to web application development.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Quizzes 10, Assignment 10, Attendance 10	Theory N/A	Practical 40	Other(specify) 30 (Project)

References/Reading Materials:

1) Hoisington, C. (2017). Microsoft Visual Basic 2017 for Windows, Web, and Database Applications: Comprehensive. 1st Edition. Course Technology.
2) Gaddis, T., Irvine, K. (2016). Starting out with Visual Basic. 7th Edition. Pearson.
3) Deitel, P. J., Deitel, H. (2016). Visual C# How to Program. 6th Edition. Pearson.
4) Sharp, J. (2018). Microsoft Visual C# Step by Step. 9th Edition. Microsoft Press.
5) Gaddis, T (2016). Starting out with Visual C#. 4th Edition. Pearson.

Semester 6			
Course Code:	BECS 32263		
Course Name:	Full-Stack Software Development		
Credit Value:	3		
Compulsory / Optional	Compulsory		
Pre-Requisites	BECS 31213		
Co-Requisites	None		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- apply the software development process
- use Front-end, Back-end and middle-tier application frameworks, libraries, and tools
- develop problem solving and logic building aptitude by gaining expertise in data structures and algorithms
- demonstrate professional skills needed in application development
- evaluate developed software using appropriate tools.
- discuss threats to privacy posed by modern technology.

Course Content:
Engage in software development process: use HTML (latest version), JavaScript libraries or framework, server can be built-in or separate, write services and work with Object Relational Mappers; Determine how to modularize components: models, controllers, data and interfaces; Single Page Application; Dependency Injection; Services; Containerization; Scalability; Testing tools; Version controlling; Introduction to the current practices and technologies. Privacy and Intellectual property: Perspective on privacy, public information intellectual property rights, trade secrets, patents and copyright; Networked Communications: email and spam, censorship, social media censorship, internet addition.

Teaching /Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment 40 %	Final Assessment 60 %		
Details: Assignments 10%, Reports / Deliverables 20 %, Attendance 10 %	Theory (%) NA	Practical (%) NA	Other (%) (specify) 60 (Project)

References/Reading Materials:

1. Northwood, Chris. (2018). The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer.
2. Zammetti, F. W. (2020). Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker
3. Hinkula, Juha. (2018). Hands-On Full Stack Development with Spring Boot 2.0 and React: Build.
4. Hoque, Shama (2018). Full-Stack React Projects: Modern Web Development Using React 16, Node.
5. Baase, S and Henry, T M (2017). A Gift of Fire: Social, Legal, and Ethical Issues for Computing Technology. 5th Edition. Pearson.

Semester 6			
Course Code:	BECS 32272		
Course Name:	Mobile Application Development		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 12243, BECS 22243		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	15	45	40

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- describe various mobile computing applications, technologies and wireless communication
- explain common paradigms in mobile computing
- develop mobile application using a selected development environment
- construct different user interfaces and review user experiences
- discuss current trends in mobile development.

Course Content:
Overview: Mobile Technologies, anatomy of a mobile device, survey of mobile devices, applications of mobile computing; Application Design: Context, information architecture, design elements, mobile web vs native Applications; Development Environments: Introduction to Android Studio and Xcode, The Model-View-Controller model, The Delegate Pattern, The iPhone and Android SDKs; The User Experience: The small screen problem, the unified look and feel paradigm, common user interface guidelines; The current trends and future of mobile development.

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Individual and group projects, Student-centred discussions

Assessment Strategy:
Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 40	Practical 20	Other(specify) N/A

References/Reading Materials:

1) Pattanaik, P. K., Mall, R. (2015). Fundamentals of Mobile Computing. 2nd Edition. PHI Learning.
2) Sinha, K., Ghosh S. C., Sinha, B. P. (2016). Wireless Networks and Mobile Computing. 1st Edition. Chapman and Hall/CRC.
3) Huang, D., Wu, H. (2017). Mobile Cloud Computing: Foundations and Service Models. 1st Edition. Morgan Kaufmann.
4) Horton, J. (2018). Android Programming for Beginners: 2nd Edition. Packt Publishing.
5) Clayton, C. (2018). iOS 12 Programming for Beginners. 3rd Edition. Packt Publishing.

Semester 6			
Course Code:	BECS 32453		
Course Name:	Digital Signal Processing (DSP)		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 22462 Signals and Systems, BECS 31433 Control Systems Design, BECS 21613 Differential Equations, Integral Transforms and Numerical Methods		
Co-Requisites	BECS 32461 Digital Signal Processing Laboratory		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand basic concepts related to Digital Signal Processing
- analysis and design of discrete-time linear-time invariant systems for processing discrete-time signals
- analyse and design digital filters; FIR and IIR filters

Course Content:

Signal sampling and quantization, Review of discrete-time (DT) signals: linearity, Time-invariance, Causality, Stability, and Convolution; Discrete-time Fourier transform and difference equations, Fast Fourier transform (FFT), Sampling theorem; Reconstruction of continuous-time signals from discrete-time signals; Interpolation and decimation, The z-transform, Basic filtering types, and Digital filter realization; Finite impulse response (FIR) and infinite impulse response (IIR),FIR filter design techniques: Frequency sampling and windowing method, IIR filter design using analogue prototypes, and Transforms from continuous-time to discrete time

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

1) Tan, L., &Jiang, J., (2013), Digital Signal Processing: Fundamentals and Applications, 2nd Edition, Academic Press
2) Ifeachor, E., & Jervis, B., (2001), Digital Signal Processing, A Practical Approach, 2nd Edition, Prentice Hall
3) Oppenheim, A. V., &Schafer, R. W., (2010), Discrete-Time Signal Processing, 3rd Edition, Pearson
4) Mitra, K. S., (2006), Digital Signal Processing: A Computer based Approach, 3rd Edition, McGraw-Hill

Semester 6			
Course Code:	BECS 32461		
Course Name:	Digital Signal Processing Laboratory		
Credit Value:	1		
Compulsory/Optional	Compulsory		
Pre-Requisites	All previous Electronics Laboratory Classes		
Co-Requisites	BECS 32453 Digital Signal Processing, BECS 31433 Communication Systems		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	20

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- use advanced electrical measuring instruments

- undertake experiments with DSP algorithms and implement them on FPGA, Microcontrollers & DSP Processors
- design, implement digital filters
- demonstrate DSP applications in communication
- image enhancement in spatial and frequency domains (through 2D Fourier transform)
- implement algorithms using MATLAB image processing toolbox

Course Content:
DSP simulations with MATLAB, DSP algorithms, MATLAB for DSP &image processing applications, DSP chips (TMS 320C 5X/6X), Verification of Linear convolution &circular convolution. Design of FIR filter (LP/HP) using windowing technique (Rectangular window, & triangular window) Implementation of IIR filter (LP/HP) on DSP processors, Implementation of N-point FFT algorithm. MATLAB program to generate sum of sinusoidal signals. MATLAB program to find frequency response of analogue LP/HP filters. Computation of power density spectrum of a sequence. Computation of the FFT of given 1-D signal. Frequency responses of anti-imaging and anti-aliasing filters

Teaching/Learning Methods:
10 lab sessions per semester (one 3hr laboratory session per week)

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Lab reports 40, Attendance 20	Theory N/A	Practical 30	Other(specify) 10 for Oral presentation or Viva

References/Reading Materials:
1) Haykin, S. & Moher, M., (2010), Communication Systems, 5th Edition, John Wiley
2) Tan, L., & Jiang, J., (2013), Digital Signal Processing: Fundamentals and Applications, 2nd Edition, Academic Press
3) Ifeachor, E., & Jervis, B., (2001), Digital Signal Processing, A Practical Approach, 2nd Edition, Prentice Hall

Semester 6			
Course Code:	BECS 32472		
Course Name:	Programmable Logic Devices and HDL		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 12443 Digital Electronics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	24	6	70

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- understand ROM structure and use it for digital circuit design
- understand the architecture of SPLDs and implement simple logic functions with them
- understand razing hazards and hazard-free design techniques
- design with CPLD
- design digital circuits with FPGAs
- demonstrate PLD programming with HDLs (VHDL or Verilog)
- design FSM and implement them with HDLs

Course Content:
ROM internal architecture, ROM as PLD, Simple programmable logic devices (SPLDs), SPLD internal architectures, Logic implementation using PGA, PLA, PLA, PLS & GAL, Controlled inverters, Output logic macrocells (OLMCs), Racing hazards in PLDs, Hazard-free design techniques, Programmable logic sequencers (PLS), Complex PLD (CPLDs), CPLD macrocells, Shared expanding, Parallel expanding, FPGA, FPGA architecture, Look up table (LUTs), Logic modules, Slices, Platform FPGAs, Hard-Core logic, IP core, Xilinx & Altera FPGAs, Generating SOP cascading chains using Vertex, ASMBL FPGAs, Programming technologies; Fusible links, Anti-fuses, EPROM, E^2PROM, SRAM, Hardware description languages (HDLs), VHDL, Verilog, VHDL examples for combinational & sequential logic design, VHDL syntax, Dataflow description, Behavioural description, State machine (Mealy & Moore machine using HDLs), Sequence recognizer example, Logic compilers, JEDEC file, JTAG boundary scanning, design entry, Logic synthesis & optimization,

Functional simulation, Timing simulation, Waveform editors, In-system programming (ISP), Xilinx ISE sample demonstrations

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions, Laboratory Classes

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Holdsworth, B.& Woods, R. C., (2002), Digital system design, 4th Edition, Newnes
2) Floyd, T. L., (2014), Digital Fundamentals, 11th Edition, Pearson
3) Chang, K. C., (1999), Digital Systems Design with VHDL and Synthesis: An integrated approach, 1st Edition, Wiley-IEEE Computer Society
4) Mano, M. M., & Kime, C., (2015), Logic and Computer Design Fundamentals, 5th Edition, Pearson
5) Xilinx ISE 9. 1 Quick Start Tutorial, Xilinx Cooperation

Semester 6			
Course Code:	BECS 32482		
Course Name:	Robotics & Automation		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	All Level 1, 2 & 3 Electronics Compulsory Course Modules		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	24	6	70

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- gain basic introductory understanding of robotics
- explain basics of manipulators, coordinate transformation and kinematics, trajectory planning, control techniques, sensors and devices
- use sensor processing algorithms to acquire and manipulate the data
- describe robot applications

Course Content:
Introduction to robotics, Role of robots in manufacturing automation, Robot configurations and classification, Essential robot components: drives, sensors, actuators, Coordinate transformation and kinematics, Trajectory planning, Robot dynamics, Modelling and control techniques, Robot application, Robot programming, Mobile robot hardware, Mobile robot design example

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions, Laboratory sessions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) John J. C., (2017), Introduction to Robotics: Mechanics and Control, 4th Edition, Prentice-Hall
2) Schilling, R. J., (1990), Fundamentals of Robotics: Analysis and Control, 1st Edition, Prentice-Hall
3) Niku, S. B., (2001), An Introduction to Robotics Analysis, Systems, Applications, Prentice-Hall

Semester 6			
Course Code:	BECS 32492		
Course Name:	Electrical Machines & Drives		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 11422 Electric Circuit Fundamentals & BECS 21422 Electromagnetism		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning

	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand electromagnetic principles and actuators including magnetic circuits and energy conversion devices
- describe the operating principles of single-phase and three-phase transformers and their applications in power supply systems
- explain basic concepts of DC machines and their operating characteristics
- apply these concepts in solving industrial problems
- gain knowledge on AC electrical machinery such as induction machines and synchronous machines

Course Content:

Electromagnetic principles, Actuators, Magnetic circuits and energy conversion devices, Transformers; Operating principles of single-phase and three-phase transformers and their applications, DC machines and their operating characteristics, AC machines; Induction machines and synchronous machines and their industrial applications, Inverters for adjustable speed drives**,** Current regulation in power converters

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Sen, P. C., (2014), Principles of Electric Machines and Power Electronics, 3rd Edition, John Wiley & Sons
2) Guru, B. S.& Hiziroglu, H. R., (2001), Electric Machinery and Transformers, 3rd Edition, Oxford University Press

Semester 6			
Course Code:	BECS 32502		
Course Name:	Micro-Electro Mechanical Systems (MEMS)		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 11413 Analogue Electronics I, BECS 22443 Measurement and Instrumentation		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate basic understanding of MEMS
- explain MEMS Fabrication processes
- understand RF MEMS and related topics
- understand some applications of MEMS such as Resonators, Filters, DNA Chip, Sensors and Actuators etc.

Course Content:

Introduction to MEMS, Materials for MEMS; Silicon, Silicon oxide and nitride, Thin metal films, Polymers, Physical effects, Piezoresistivity, Piezoelectricity, Thermoelectricity, Micromachining; Epitaxy, Oxidation, Sputter deposition, Evaporation, Chemical vapour deposition (CVD), Lithography, Etching, Ultra-precision mechanical machining, Laser machining, Electro-discharge machining, Screen printing, Micro contact printing, Soft lithography, Nano-imprint lithography(NIL), Hot embossing, Ultrasonic machining, MEMS in RF applications, Signal integrity in RF MEMS, Passive components; Capacitors and Inductors, Quality factor, Surface-micro machined variable capacitors, Bulk-micro machined variable capacitors, Micro machined inductors, Microelectromechanical resonators, Comb-drive Resonators, Beam Resonators, Coupled-Resonator, Bandpass Filters, Film bulk acoustic resonators, Microelectromechanical switches, Membrane shunt switch, Cantilever series switch, Life science applications; DNA chip, MEMS in Industrial and automotive applications; Sensing and actuation, Fluid nozzles, Pressure sensors, High-temperature pressure sensors, Mass flow sensors, Acceleration sensors, Angular rate sensors and gyroscopes, Carbon monoxide gas sensor

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:			
Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Maluf**,** N., & Williams, K., (2004), An Introduction to Microelectromechanical Systems Engineering, 2nd Edition, Artech House Inc.
2) Allen, J. J., (2005), Micro Electro Mechanical System Design, 1st Edition, CRC Press
3) Choudhary, V., & Iniewski, K., (2013), MEMS: Fundamental Technology and Applications, CRC Press, 1st Edition

Semester 6			
Course Code:	BECS 32811		
Course Name:	Creative Design Project II		
Credit Value:	1		
Compulsory/Optional	Compulsory		
Pre-Requisites	All previous Compulsory courses		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	30	70

Course Aim/Intended Learning Outcomes:

The aim of this course is to encourage students to get familiar with the process of scientific problem solving through a set project. Students can choose their projects from either Computer Science or Electronics discipline. At the completion of this course students will be able to:

- collaborate as a team to produce a practical design meeting the given objectives using relevant concepts learnt during previous courses
- analyse, design, simulate and build simple electronic circuits
- write a project plan, document progress in detail, and conduct design reviews
- convince others via effective communication, both orally and in writing
- improve technical abilities

Course Content:

This course is conducted throughout the second semester of level 3. This is a group project and each group will include a group of 3 to 5 students. They must carry out a given design project over the semester. The students are expected to apply the knowledge and skills acquired in the first, second, and third level in order to implement the design produced. They are expected to develop skills in group and team management while carrying out their task. They have to work within a specified time scale

Teaching/Learning Methods:

PODBL (Project Oriented Design Based Learning) method will be utilized

Assessment Strategy:			
Continuous Assessment (80%)	Final Assessment (20%)		
Details: Project proposal 10, Project Progress Presentation 10, Project Report 40, Attendance 20	Theory N/A	Practical N/A	Other(specify) Viva 10 Demonstration 10

References/Reading Materials:

1) Ford, R. & Coulston, C., (2005), Design for electrical and computer engineers: Theory, concepts, and practice, 1st Edition, McGraw-Hill
2) Other material as appropriate depending on the given objectives

Semester 6			
Course Code:	BECS 32742		
Course Name:	Operations Management		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe operations management and its process
- explain the relationship between operations management and organizational strategies
- apply operational management tools in organizational work process
- assessment of risk related with the business operation
- understand supply chain management principles

Course Content:

Introduction to operations management, Operations strategy and competitiveness, Designing service delivery system, Product design and new product development, Plant location, Production layouts and process analysis, Production planning, Capacity planning, Forecasting in operations, Inventory management, Material requirements planning, Managing quality, Risk assessment in operations, Just-in-time and lean manufacturing, Introduction to supply chain management and global supply chain management

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Assignment 20, Attendance 10	Theory 70	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Chase, Jacobs, Aquilano, (2006), Operations Management for Competitive Advantage with Global Cases, McGraw-Hill
2) Krajewski, L. J., Ritzman, L. P., Malhotra, M. K., (2006), Operations Management: Processes and Value Chains. 8th Edition, Prentice Hall
3) Heizer, J. & Render, B., (2007), Principles of Operations Management, 7th Edition, Pearson Education
4) Russell, R. S., Taylor, B. W., (1999), Operations Management with Multimedia CD, 3rd Edition, Prentice Hall

Semester 7/ 8			
Course Code:	BECS 44213		
Course Name:	Wireless Communication and Networks		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 12233		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- explain the concepts of wireless communication systems
- discuss generations of mobile networks
- assess different wireless networks and communication infrastructures
- review basic cellular system, frequency reuse, channel assignment strategies, handoff strategies and interference
- explain the multiple access technique for wireless communications
- design a simple wireless communication network.

Course Content:

Introduction to wireless communication systems: Evaluation of mobile radio communications, examples of wireless communication systems, paging systems, cordless telephone systems, compression of various wireless systems; Mobile wireless communication systems: second generation cellular networks, third generation wireless networks, wireless in local loop, wireless local area networks, Bluetooth and personal area networks; Cellular system design fundamentals: spectrum allocation, basic cellular system, frequency reuse, channel assignment strategies, handoff strategies, interference and system capacity, trucking and grade off service, improving coverage and capacity, cell splitting; Multiple access technique for wireless communications: introduction to multiple accesses, FDMA, TDMA, spread spectrum multiple access, SDMA, packet radio, capacity of cellular systems; Wireless Networking: Difference between wireless and fixed telephone networks, development of wireless networks, fixed network transmission hierarchy, traffic routing in warless networks, wireless data

services, common channel signaling, Wireless LAN technology and Standards, Bluetooth, GPRS and 3G wireless systems, Wireless WAN communication in the infrastructure.

Teaching/Learning Methods:
Lectures, Tutorials, Assignments. Student Centred Discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1. Stallings, W. (2004). Wireless Communications and Networking. 2nd Edition. Prentice-Hall of India.
2. Garg, V. (2010). Wireless communications & networking. Elsevier.
3. Faludi, R. (2010). Building wireless sensor networks: with ZigBee, XBee, arduino, and processing. O'Reilly Media, Inc..
4. Osseiran, A., Monserrat, J. F., Marsch, P. (Eds.). (2016). 5G mobile and wireless communications technology. Cambridge University Press.

Semester 7/ 8			
Course Code:	BECS 44223		
Course Name:	Blockchain and Cryptocurrency		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 12233		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- explain the essential features of blockchain
- identify scenarios and implementation of appropriate design considerations for a distributed ledger
- use smart contracts in terms of their design and communication between the different entities
- acquire a good understanding of different protocols and technologies used in cryptography
- demonstrate an understanding of the process involved within mining and trading of cryptocurrencies
- use of different interfaces to interact with cryptocurrencies
- describe the proper use of wallets and hardware wallets

Course Content:
Introduction to Blockchain: Transactions, Blocks, Hashes; Public and Private blockchain; Distributed ledger; Consensus verification: Byzantine generals problem, Proof Of Work (POW), Proof Of Stake (POS), Delegated POS (DPOS); Smart Contracts; Future and the application of the blockchain; Introduction to Cryptocurrencies; Bitcoin History; Bitcoin; Ethereum; Initial Coin Offerings (ICOs); Bitcoin Mechanics and Optimizations: A Technical Overview; Bitcoin in real life: Wallets, mining; Game Theory and Network Attacks: How to Destroy Bitcoin; Future of the cryptocurrencies.

Teaching/Learning Methods:
Lectures, Tutorials, Assignments. Student Centred Discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., Goldfeder, S. (2016). Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press.
2. Antonopoulos, A. (2017). Mastering Bitcoin. 2nd Edition. O'Reilly Media.
3. Werbach, K. (2018). The Blockchain and the New Architecture of Trust. The MIT Press.
4. Bashir, I. (2020). Mastering Blockchain: A deep dive into distributed ledger, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more. 3rd Edition. Packt Publishing.
5. Lewis, A. (2018). The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them. Mango Media.

Semester 7 / 8			
Course Code:	BECS 44223		
Course Name:	Intelligent Systems		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11212, BECS 21223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand various definitions of Artificial Intelligence
- apply search techniques for problem solving
- identify and use different knowledge representation techniques
- analyze and select the most efficient and appropriate mechanism applicable to a given problem that can be solved using artificial intelligence.

Course Content:

The history of artificial intelligence and foundations of artificial intelligence; Intelligent agents: Agents and Environments, The Nature of Environments, Structure of agents, Classes of intelligent agents, Hierarchies of agents, Problem-Solving Agents; Intelligent search techniques: Uninformed search, Informed (Heuristic) search, Adversarial Search, Games as search problems; Learning and Knowledge Representation: Forms of Learning, Logic-based representation, Procedural representations, Structured representations; Languages and programming techniques for Artificial Intelligence; Overview of major areas and Future trends in Artificial Intelligence.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Russell, S. J., Norvig, P. (2009). Artificial Intelligence: A Modern Approach. 3rd Edition. Prentice Hall.
2) Luger, G. F. (2008). Artificial Intelligence: Structures and Strategies for Complex Problem Solving. 6th Edition. The Benjamin/Cummings Publishing Company, Inc.
3) Yao, M., Zhou, A., Jia, M. (2018). Applied Artificial Intelligence: A Handbook for Business Leaders. 1st Edition. TOPBOTS.
4) Neapolitan, R., Jiang, X. (2012). Contemporary Artificial Intelligence. Chapman & Hall.
5) Stone, J. V. (2019). Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning. Sebtel Press.

Semester 7 / 8			
Course Code:	BECS 44233		
Course Name:	Computer Graphics and Visualization		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11223, BECS 11613		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- explain fundamental concepts within computer graphics such as geometrical transformations, illumination models, removal of hidden surfaces and rendering
- identify the features in fundamental algorithms of computer graphics to compare and evaluate them
- apply fundamental principles within interaction programming
- demonstrate fundamental concepts within information visualization and scientific visualization.

Course Content:

Introduction: History of computer graphics, applications, graphics pipeline, physical and synthetic images, synthetic camera, modeling, animation, rendering, relation to computer vision and image processing, review of

basic mathematical objects (points, vectors, matrix methods); Introduction to OpenGL: OpenGL architecture, primitives and attributes, simple modeling and rendering of two- and three-dimensional geometric objects, indexed and RGB color models, frame buffer, double buffering, GLUT, interaction, events and callbacks, picking; Geometric transformations: Homogeneous coordinates, affine transformations (translation, rotation, scaling, shear), concatenation, matrix stacks and use of model view matrix in OpenGL for these operations; Viewing: Classical three dimensional viewing, computer viewing, specifying views, parallel and perspective projective transformations, Visibility- z-Buffer, BSP trees, Open-GL culling, hidden-surface algorithms; Shading: Light sources, illumination model, Gouraud and Phong shading for polygons. Rasterization- Line segment and polygon clipping, 3D clipping, scan conversion, polygonal fill, Bresenham's algorithm; Discrete Techniques: Texture mapping, compositing, textures in OpenGL; Ray Tracing- Recursive ray tracer, ray-sphere intersection; Representation and Visualization: Bezier curves and surfaces, B-splines, visualization, interpolation, marching squares algorithm.

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Individual and Group Projects Student-centred discussions

Assessment Strategy:
Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Quizzes 5, Assignment 15, Attendance 10	Theory 50	Practical 20	Other(specify) N/A

References/Reading Materials:

1) Angel, E., Shreiner, D. (2014). Interactive Computer Graphics with WebGL. 7th Edition. Pearson.
2) Gordon, V. S., Clevenger, J. L. (2018). Computer Graphics Programming in OpenGL with JAVA 2nd Edition. Mercury Learning & Information.
3) Gortler, S. J. (2012). Foundations of 3D computer graphics. MIT Press.
4) Marschner, S., Shirley, P. (2015). Fundamentals of computer graphics. 4th Edition. CRC Press.

Semester 7 or 8			
Course Code:	BECS 44243		
Course Name:	High Performance Computing		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 12233, BECS 22233		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	30	90

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- develop and apply knowledge of high performance computing techniques and methodologies
- apply design, development, and performance analysis of high performance applications
- use the application of fundamental Computer Science methods and algorithms in the development of parallel applications
- explain the design, testing, and performance analysis of a software system.

Course Content:
Introduction to High Performance Computing; Parallel and Distributed Architectures; Socket programming; Parallel Performance; Shared Memory and Threads; Parallel Algorithms; OpenMP; Scalable Algorithms; Message Passing; MPI and Teragrid; Distributed Systems; MapReduce; Clusters; Distributed Coordination and Security; Distributed File Systems and Security.

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Individual and Group Projects Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Quizzes 5, Assignment 15, Attendance 10	Theory 50	Practical N/A	Other(specify) 20 (Project)

References/Reading Materials:

1) Grama, A., Kumar, V., Gupta, A., Karypis, G. (2003). Introduction to parallel computing. 2nd Edition. Pearson Education.
2) Tanenbaum, A. S., Van Steen, M. (2016). Distributed systems: principles and paradigms. 2nd Edition. CreateSpace Independent Publishing Platform.

3) Quinn, M. J. (2004). Parallel Programming in C with MPI and OpenMP. McGraw Hill.
4) Kirk, D. B., Wen-Mei, W. H. (2016). Programming massively parallel processors: a hands-on approach. Morgan Kaufmann.

Semester 7/8			
Course Code:	BECS 44253		
Course Name:	Emerging Technologies in Computer Science		
Credit Value:	3		
Compulsory / Optional	Optional		
Pre-Requisites	All compulsory course units of level 1, level 2 and level 3.		
Co-Requisites	None		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	NA	105

Course Aim/Intended Learning Outcomes:
At the completion of this course student will be able to:
- demonstrate the theoretical knowledge on basic concepts learned on the selected emerging technologies.

Course Content:
Depends on the selected emerging technologies.

Teaching /Learning Methods:
Combination of Lectures, Tutorial discussions, Group Projects, Student-centred discussions

Assessment Strategy:
Note: Theory and Practical weightages to be decided based on the selected emerging technologies.

Continuous Assessment 40 %	Final Assessment 60 %		
Details: Quizzes 10%, Assignment 30 %	Theory (%) 60	Practical (%) NA	Other (%)(specify) NA

References/Reading Materials:
Reading list and material relevant for each selected topic to be provided at the beginning of the academic year by the lecturer.

Semester 7 or 8			
Course Code:	BECS 44263		
Course Name:	Machine Learning		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 44223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	30	90

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- explain necessity of machine learning
- describe wide variety of learning algorithms
- compare and contrast different learning models
- solve real world problems using machine learning techniques
- demonstrate programming skills that will necessary to build intelligent, adaptive artifacts.

Course Content:
Introduction to machine learning; Types of Learning (Supervised, Unsupervised and Reinforcement); Inductive Classification; Decision Tree Learning; Ensemble Learning; Experimental Evaluation of Learning Algorithms; Computational Learning Theory; Rule Learning: Propositional and First-Order; Artificial Neural Networks; Support Vector Machines; Bayesian Learning; Genetic Algorithms; Instance-Based Learning; Clustering; Dimensionality Reduction; Association Rule Discovery; Language Learning; Text Classification; Introduction to Reinforcement Learning models.

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Individual and Group Projects Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Mitchell, T. M. (1997). Machine Learning, McGraw-Hill.
2) Bishop, C. M. (2011). Pattern recognition and machine learning. Springer.
3) Alpaydin, E. (2016). Machine learning: the new AI. MIT press.
4) Shalev-Shwartz, S., Ben-David, S. (2014). Understanding machine learning: From theory to algorithms. Cambridge university press.
5) Hastie, T., Tibshirani, R., Friedman, J. (2016). The elements of statistical learning: data mining, inference, and prediction. 2nd Edition. Springer Series in Statistics.
6) Goodfellow, I., Bengio, Y., Courville, A. (2016). Deep learning. MIT press.
7) Géron, A. (2017). Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems. O'Reilly Media, Inc..

Semester 7 or 8			
Course Code:	BECS 44273		
Course Name:	Game Development		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 32232		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	30	90

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe theoretical foundation of game design
- explain and practice the stages of game design process
- describe and apply the agile production methods and prototyping in game designing
- explain the importance of a game design framework: mechanics, dynamics and aesthetics (MDA)
- recognize the players and player types in game design
- formulate a theoretical game design to a specific brief, implementing effective game narrative, playtesting and balancing
- analysis game designs constructively based on understanding of good game design principles
- synthesize various game design concepts into a game design project.

Course Content:

Overview of a game; Atomic elements of games; Stages of game design process; Game design frameworks: MDA (mechanics, dynamics and aesthetics); Iteration and rapid prototyping for game design; Decisionmaking and flow theory in game design; Kinds of fun, Kinds of players; Game narrative and Storytelling;
Games designing tools; Playable prototype design; Game criticism; Playtesting; Game designs evaluation in terms of game balance; Game designs analysis in terms of user interface design; Development and Production.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Individual and Group Projects Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 50	Practical 10	Other(specify) N/A

References/Reading Materials:

1) Fullerton, T. (2018). Game Design Workshop: A Playcentric Approach to Creating Innovative
2) Games. 4th Edition. A K Peters/CRC Press.
3) Schell, J. (2014). The Art of Game Design: A book of lenses. 2nd Edition. AK Peters/CRC Press.
4) Zubek, R. (2020). Elements of Game Design. The MIT Press.
5) Koster, R. (2013). Theory of Fun for Game Design. 2nd Edition. O'Reilly Media.

Semester 7/8	
Course Code:	BECS 44283
Course Name:	Advanced Databases

Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 22243		
Co-Requisites			
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to demonstrate:

- ➢ apply the principles of query optimization to a database schema
- ➢ identify transaction processing
- ➢ apply concurrency control techniques
- ➢ describe different types of database failures
- ➢ apply appropriate recovery techniques
- ➢ formulate complex queries
- ➢ develop stored procedures, functions and triggers
- ➢ design queries against a distributed database management system
- ➢ design queries against database designed with object-relational extensions
- ➢ develop and query No-SQL databases.

Course Content:

Advanced Features of SQL: Relational algebra review and join commands, additional join operations, SELF join, FULL joins, Set-Theoretic operators, the HAVING clause, views; Stored Procedures and Triggers: Stored Procedures and their usage in relational database management systems, stored functions, constraints and triggers; Query Optimization: Stages in query processing, query processing algorithms, query plan execution, cost-based query optimization; Concurrency and Recovery: Transactions and the ACID property of transactions, serializability and the serializability theorem, two-phase locking, time ordering techniques, recovery techniques; Database System Architectures: Centralized and Client-Server systems, parallel databases, distributed databases, heterogeneous and homogeneous databases, distributed query processing;
No-SQL Databases: Motivations for Not Just/No SQL (NoSQL) databases, variety of NoSQL databases, introduction to Key-Value databases, Key-Value database.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Individual and Group Projects Student-centred discussions

Assessment Strategy:

Note: Practical examination is compulsory to obtain the final grade in the course.

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 10, Assignment 30, Attendance 10	Theory 40	Practical 20	Other (specify) N/A

References/Reading Materials:

1) Elmasri, R. (2017). Fundamentals of database systems. 7th Edition, Pearson Education India.
2) Silberschatz, A., Korth, H. F., & Sudarshan, S. (2019). Database system concepts. 7th Edition. McGraw-Hill.
3) Molinaro, A. (2005). SQL Cookbook: Query Solutions and Techniques for Database Developers. " O'Reilly Media, Inc.".
4) Perkins, L., Redmond, E., & Wilson, J. (2018). Seven databases in seven weeks: a guide to modern databases and the NoSQL movement. 2nd Edition. Pragmatic Bookshelf.
5) Harrison, G. (2015). Next Generation Databases: NoSQL and Big Data. Apress.
6) McLaughlin, M., & Harper, J. (2014). Oracle Database 12c PL/SQL advanced programming techniques. McGraw-Hill Education Group.

Semester 7 or 8			
Course Code:	BECS 44414		
Course Name:	Power Electronics		
Credit Value:	4		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11413 I Analogue Electronics I & BECS 21413 Analogue Electronics II		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning

	48	12	140

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe the operations of power semiconductor devices such as Diodes, BJTs, IGBTs, MOSFETS, Thyristors, SCS, SCR etc.
- analyse and design AC/DC Rectifiers
- describe the operation and design switch mode DC-DC convertors

Course Content:

Power semiconductor devices, Diodes, BJTs, Insulated-Gate Bipolar Transistor (IGBT), Thyristors, MOSFETS, Silicon controlled switch (SCS), Silicon controlled rectifiers (SCR), Switching characteristics, Uncontrolled and controlled rectifiers, SCR power control, dc-dc switch mode converters; Buck converter, Boost converter, Buck-boost converter, Full bridge converter, DC/AC inverters, Voltage source inverters, Current source inverters, PWM methods

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Quizzes 5, Assignment 5, Attendance 10, Laboratory 10	Theory 70	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Mohan, N., (2012), Power Electronics, A first course, 1st Edition, John Wiley & Sons
2) Hart, D. W., (2010), Power Electronics, 1st Edition, McGraw-Hill
3) Mohan, N., Undeland, T. M., & Robbins, W. P., (2003), Power Electronics: Converters, Applications, and Design, John Wiley, 3rd Edition
4) Rashid, M. H., (2013), Power Electronics: Circuits, Devices & Applications, 4th Edition

Semester 7 or 8			
Course Code:	BECS 44424		
Course Name:	CMOS VLSI system design		
Credit Value:	4		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 11413 Analogue Electronics I, BECS 22462 Analogue Electronics II & BECS 12443 Digital Electronics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	60	N/A	140

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand basics of CMOS VLSI design process
- gain clear understanding on VLSI Design rules
- design and layout basic CMOS integrated circuits by applying the common design techniques for optimization (Sketch digital circuits in transistor level)
- sketch the layout of simple circuit according to the layout design rules
- do the timing analysis (Estimate the delay of logic gates)
- performance estimation of VLSI circuits
- understand the trade-offs and issues in modern VLSI design
- design and optimize complex functional blocks
- use commercial CAD tools for design and optimization

Course Content:

IC design history, Overview of CMOS design; CMOS Transistor basics, CMOS Logic, Compound gates, Pass transistors, Transmission gates, Tristate gates, Multiplexers, Latches and Flip-Flops, CMOS processing technology; Layout design rules, MOS Transistor theory; Operation, Ideal IV characteristics, CV characteristics, Simplified MOS capacitor model, Diffusion capacitance, Non-Ideal effects; Velocity saturation, Mobility degradation, Channel length modulation, Body effect, Sub threshold conduction, Junction leakage, Tunnelling, Temperature dependence, Geometry dependence, Circuit characterization and performance estimation, Delay estimation; RC Delay models ,Elmore delay model, Linear delay model, Logical effort, Electrical effort, Transistor sizing, Branching effort, Stage effort, Choosing the best no of stages for given

design, Asymmetric gates, Skewed Gates, Pseudo-nMOS Logic, Dynamic Logic, Monotonicity, Pass transistor logic, Domino gates, Sequential circuits, Floor planning, Sequencing, Sequencing Element design, Max and min-Delay, Clock skew, Time borrowing, Two-phase clocking, Interconnect, Wire engineering & reliability, Packaging, Introduction to VLSI Design automation using CAD tools
Teaching/Learning Methods: Combination of Lectures, Tutorial discussions, Student-centred discussions
Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Weste, N. H. E. & Harris, D. M., (2005), CMOS VLSI design, A circuit and system perspective, 4th Edition, Pearson
2) Weste, N. H. E.& Harris, D. M., (2011), Integrated Circuit Design, 4th Edition, Pearson
3) Wolf, W., (2002), Modern VLSI Design: System-on-Chip Design, 3rd Edition, Prentice Hall
4) Kang, S. M. & Leblebici, Y., (2003),CMOS Digital Integrated Circuits, 3rd Edition, McGraw-Hill

Semester 7 or 8			
Course Code:	BECS 44434		
Course Name:	Special Topics in Electronics		
Credit Value:	4		
Compulsory/Optional	Optional module for Honours Degree in Electronics and Computer Science		
Pre-Requisites	All the Compulsory course modules in Electronics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	60	N/A	140

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- improve knowledge in interdisciplinary areas of electronics
- acquire insight into some selected areas of electronics

Course Content:

Biomedical electronics, Metamaterials, Green electronics, Optoelectronics, Radar systems, Quantum electronics, Neuromorphic architectures, Optical computing, Brain-inspired computing
(Only 3 topics (20 h each) from above list will be taught during an academic year depending on the availability of Staff)

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Sawhney, G. S., (2011), Biomedical Electronics and Instrumentation, I.K. International Publishing House; 1st Edition
2) Saleh, B. E. A., & Teich, M. C., (2007), Fundamentals of Photonics, 2nd Edition, Wiley-Inter Science
3) Cui, T. J., Smith, D., &Liu, R., (2010), Metamaterials: Theory, Design, and Applications, Springer
4) Skolnik, M., (2002), Introduction to Radar Systems, 3rd Edition, McGraw-Hill Education
5) Nagourney, W., (2014), Quantum Electronics for Atomic Physics and Telecommunication, 2nd Edition, Oxford University Press

Semester 7 or 8	
Course Code:	BECS 44443
Course Name:	RF & Microwave Circuits Design
Credit Value:	3
Compulsory/Optional	Optional
Pre-Requisites	BECS 11413 Analogue Electronics I
Co-Requisites	N/A

Hourly Breakdown	Theory	Practical	Independent Learning
	39	6 (Simulation - ADS)	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand the basics of RF circuit design
- understand signal flow graphs and their applications
- analyse microwave circuits using Z, Y, ABCD, and S-parameters
- design and analyse planar transmission lines
- design and analyse micro strip circuits
- analyse microwave circuits using lumped circuit simulation and EM Simulation

Course Content:

Radio-frequency circuits design, Impedance matching, Smith chart & operations. Small-signal RF amplifiers, Mixers, RF power amplifiers, Oscillators, Phase-locked loop (PLL) circuits, signal flow graphs and their applications in microwave circuit analysis and design, *Z, Y, ABCD* and *S*-parameters, Two port parameters, Scattering matrix parameters, Planar transmission lines, Microstrip line design, Lumped/distributed circuit elements, Impedance matching circuits, resonators, dividers, couplers, filters and duplexers

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions, Laboratory Class

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Quizzes 5, Assignment 5, Attendance 10, Laboratory 10	Theory 70	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Pozar, D. M., (2012), Microwave Engineering, 4th Edition, John Wiley
2) Jia-Sheng, H. & Lancaster, M. J., (2011), Microstrip Filters for RF/Microwave Applications, 2nd Edition, John Wiley
3) Reinhold, L. & Pavel, B., (2008), RF Circuit Design: Theory and Applications, 2nd Edition, Prentice-Hall
4) Joseph, F. W., (2016), High Frequency Techniques: An Introduction to RF and Microwave Engineering, 1st Edition, Wiley-IEEE Press
5) Collin, R. E., (1992), Foundations of Microwave Engineering, 2nd Edition, McGraw-Hill

Semester 7 or 8			
Course Code:	BECS 44453		
Course Name:	Industrial Electronics		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	All Electronics Compulsory course modules		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- apply safety policies, standards, practices and procedures to the industrial environment
- use terminology in the field of industrial electronics
- read and interpret electrical/electronic drawings
- perform tests using common electronic equipment
- troubleshoot electrical/electronic systems
- demonstrate necessary mathematical skills
- demonstrate configuration of computer controlled equipment
- demonstrate machine control understanding
- demonstrate basic hydraulic and pneumatic knowledge
- develop programs to operate and monitor automated equipment

Course Content:

Industrial panels &wiring, Industrial times, Industrial measuring tools, Ammeters, Voltmeters &energy meters, Temperature controllers, Faults and errors of Industrial electronic system, Tools and instruments for testing and identifying faults, Fault detection and diagnosis, Troubleshooting, Repairing faults, Maintenance of Industrial

electronic systems, Safety measures in Industrial environment, Health hazards of electronic systems, Radiation protection etc., Reporting and documentation of industrial problems

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Quizzes 10, Assignment 40, Attendance 10	Theory 40	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Bushnell, M. L. & Agrawal, V. D., (2004), Essentials of electronic testing, Springer
2) Ahmed, R. F., & Soliman, A. M., (2014), Testing Methods for Fault Detection In Electronic Circuits, Academic Publishing
3) Khandpur, R. S., (2006), Troubleshooting Electronic Equipment, McGraw-Hill
4) Lala, P. K., (2008), An Introduction to Logic Circuit Testing, Morgan & Claypool Publishers
5) Lundquist, L., (1999), Industrial Electrical Troubleshooting, 1st Edition, Delmar Cengage Learning
6) Hand, A., (2011), Electric Motor Maintenance and Troubleshooting, 2nd Edition, McGraw-Hill Education
7) Anderson, G. D., (2013), Variable Frequency Drives: Installation & Troubleshooting, Practical Guides for the Industrial Technician, Create Space Independent Publishing Platform

Semester 7 or 8			
Course Code:	BECS 44462		
Course Name:	Industrial Automation		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 31443 Control Systems Design & BECS 22443 Measurement and Instrumentation		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- describe and explain basics of an industrial automation system
- explain practical programmable logic controller applications and associated sensors
- explain industrial progression toward automation; employ control methods and procedures; select appropriate sensors; and incorporate proper set-up, maintenance, and testing for automation

Course Content:
Basic components in industrial automated systems, Controllers, Sensors and actuators in industrial automation, Safety requirement in industrial automation, Programmable logic controllers (PLCs), Concept of sequential control, PLC hardware selection, Programming methods for PLCs, Timers and Counters , Supervisory control and data acquisition (SCADA) systems, Sustainable lighting technology, Solar powered systems, Automotive electronics; Electric, Hybrid and plug-in hybrid vehicles

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Lamb, F., (2013), Industrial Automation: Hands-On, 1st Edition, McGraw-Hill
2) Smith, L. L., Rowlett, M. L., & Womack, R. C., (1996), Fundamentals of Industrial Controls and Automation: Basic Text on Electricity, Electronics, Control Components and Automation, 1st Edition, Womack Educational Publications
3) Adrover, E. P., (2012), Introduction to PLCs: A beginner's guide to Programmable Logic Controllers
4) Cetinkunt, S., (2015), Mechatronics with Experiments, 2nd Edition, Wiley

Semester 7 or 8

Course Code:	BECS 44716		
Course Name:	Industrial Training		
Credit Value:	6		
Compulsory/Optional	Compulsory		
Pre-Requisites	All Compulsory courses of Level 1, 2 & 3		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	960 (6 months)	N/A

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- apply theoretical knowledge in an industrial & professional setting
- develop professional competencies and relationships
- develop exposure to a professional field and an understanding of professional etiquette
- evaluate the professional organizational culture
- evaluate critically the internship experience as an exemplar for the field
- prepare a professional report on the training

Course Content:

Apply theoretical knowledge in an industrial & professional setting, Development of professional competencies and interpersonal relationships, Develop exposure to a professional field and an understanding of professional etiquette. The student should learn from observing the professional behaviour of the supervisor and other employees at the site, as well as through interaction with customers or clients. The student also practices proper business etiquette while fulfilling his or her training responsibilities, and evaluates the professional organizational culture. The student should be able to understand the dynamics of an organization's culture through observing and reflecting on how decisions are made, how work is structured, how power is shared, how colleagues interact, how an organization's mission/vision are implemented, find to what degree accountability and feedback are present in the organization, evaluate critically the internship experience as an exemplar for the field, compose a professional report on the training, and learn the basic structure and ingredients of a technical report on an industrial experience

Teaching/Learning Methods:

Supervisor of the industrial organization will assign a project to be completed at the end of the training period

Assessment Strategy:

Continuous Assessment (70%)	Final Assessment (30%)		
Details: Attendance 30, Technical Report 40 (evaluated by both industry and academic supervisors)	Theory N/A	Practical N/A	Other(specify) Oral presentation based on technical report 30

References/Reading Materials:

1) Students must find relevant material under guidance of field supervisor if they need any

Semester 7 or 8			
Course Code:	BECS 44472		
Course Name:	Electronic Product Design and Manufacturing		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	All Compulsory courses in Electronics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- define the basic steps in electronic product design and manufacture
- perform worst case analysis of electronic circuits
- identify and analyse noise and signal integrity issues in electronic circuits
- EMC & EMI matters
- design an electronic product (from concept through PCB to casing)
- test electronic products

Course Content:

Product design and development, Product design process, Estimating power supply requirement (Power supply sizing), Power supply protection devices, Noise consideration of a typical system, Noise in electronic circuit,

Measurement of noise, Grounding, Shielding and Guarding, Signal integrity issues, EMI & EMC in Electronic Circuits, Shielding & grounding. PCB designing, Product testing, Enclosure sizing & supply requirements & materials for enclosure and tests carried out on enclosure, Thermal management and its types, Advanced topics in electronic product design and manufacture, Electronic product design mini project. Electronics Manufacturing Automation (EMA)

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Quizzes 10, Assignment 40, Attendance 10	Theory 40	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Ward, A. E., &Angus, J. A. S., (1996), Electronic Product Design, CRC Press
2) Judd, M.& Brindley, K., (1999), Soldering in Electronics Assembly, 2nd Edition, Newnes
3) Edwards, P., (2013), Manufacturing Technology in the Electronics Industry: An introduction 1st Edition, Springer
4) Landers, T. L., Browne, W. D., Fant, E. W., Malstrom, E. M., & Schmitt, N., (1994), Electronics Manufacturing Processes Facsimile Edition, Prentice Hall
5) Coombs, C., &Holden, H., (2016), Printed Circuits Handbook, 7th Edition, McGraw-Hill
6) Mathia, K., (2010), Robotics for Electronics Manufacturing - Principles and Applications in Cleanroom Automation, 1st Edition, Cambridge University Press

Semester 7 and 8

Course Code:	BECS 43816		
Course Name:	Research Project (Group)		
Credit Value:	6		
Compulsory/Optional	Compulsory		
Pre-Requisites	All Compulsory courses		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	180	420

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to demonstrate competence in:

- planning and carrying out a research project in Electronics
- identifying, defining and investigating a research problem in electronics to provide a solution
- writing a research project plan, documenting progress in detail, and conducting progress reviews
- using suitable electronics principles to solve a research/design problem
- writing a dissertation on the research findings and presenting the results to convince others via effective communication, both in writing and orally
- ethical research practices, and improvement of technical abilities

Course Content:
A group of students will be assigned a research project in Computer Science or Electronics. The project must include identifiable individual components and group components. Initially students have to submit a project proposal and select suitable project supervisor(s). The students' progress will be evaluated regularly by the supervisor and the examination panel. A project report in the form of a dissertation will be submitted at the end of the project.

Teaching/Learning Methods:
PODBL (Project Oriented Design Based Learning) method will be utilized

Assessment Strategy:

Continuous Assessment (100%)	Final Assessment (0%)		
Details: Research proposal (after one month of Level 4) 10, Research progress presentation (at the beginning of Semester 2) 10, Project Demonstration 10, Final oral presentation 20, Dissertation 40, Presentation at symposium 10 (Mini symposium will be organised by the Departments and evaluated by external field experts)	Theory N/A	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Students must find related references themselves

Semester 5 & 6			
Course Code:	BECS 43033		
Course Name:	Advanced Experimental Laboratory I		
Credit Value:	5		
Compulsory/Optional	Compulsory		
Pre-Requisites	All previous Compulsory course modules in Electronics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	150	100

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate skills in advanced experimental techniques through laboratory work on areas of Power electronics, Microcontrollers, Embedded systems, Control systems, Communication systems, DSP, Image processing, Semiconductors & Electromagnetism
- designing and planning of laboratory experiments their own once the final goal is given
- writing comprehensive laboratory reports and presenting results based on the analysis of experimental data

Course Content:

Power electronics, Microcontrollers, Embedded systems, Control systems, Communication systems, DSP & Image processing, Semiconductor materials, Electromagnetism

Teaching/Learning Methods:

6 hours of laboratory classes per week and independent learning, PODBL (Project Oriented Design Based Learning)

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Laboratory Reports 50, Attendance 10	Theory N/A	Practical 40	Other (specify) N/A

References/Reading Materials:

1) Students must do literature survey of their own and find suitable references once the goal of experiment is given to them

Semester 6			
Course Code:	BECS 44014		
Course Name:	Advanced Analogue Electronics		
Credit Value:	4		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11413 Analogue Electronics I, BECS 24114 Analogue Electronics II & BECS 11422 Electric Circuit Fundamentals		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	60	N/A	140

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand basic MOS device physics in depth
- understand the operation of a Single stage amplifier, Differential amplifier, LNA, PA, Current mirrors, VCO & PLL in detail
- analyse biasing, frequency response, stability, and noise performance of given analogue integrated electronic circuits
- design and analyse complex analogue electronic circuits

Course Content:

MOS device physics, Single stage amplifiers, Differential amplifiers, Passive and active current mirrors, Frequency response of amplifiers, Wide-bandwidth amplifiers, Noise, Low noise circuits, Low noise amplifiers (LNA), Power amplifiers (PA), Feedback, Band gap references, Switched capacitor circuits, Voltage controlled oscillators (VCOs), Phased looked loops (PLLs)

Teaching/Learning Methods: Combination of Lectures, Tutorial discussions, Student-centred discussions			
Assessment Strategy:			
Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other(specify) N/A
References/Reading Materials: 1) Razavi, B., (2001), Design of Analogue CMOS Integrated Circuit, 1st Edition, McGraw-Hill 2) Sergio, F., (2014), Design with Operational Amplifiers and Analogue Integrated Circuits, 4th edition, McGraw-Hill 3) Paul, R. G., (2009), Analysis and Design of Analogue Integrated Circuits, 5th Edition, John Wiley 4) Carusone, T. C., (2011), Analogue Integrated Circuits Design, 2nd Edition, John Wiley			

Semester 6			
Course Code:	BECS 44024		
Course Name:	Advanced Electromagnetism		
Credit Value:	4		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11422 Electric Circuit Fundamentals, BECS 21422 Electromagnetism & All Mathematics Courses		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	60	N/A	140
Course Aim/Intended Learning Outcomes: At the completion of this course students will be able to: ➢ demonstrate knowledge of electromagnetic theory ➢ formulate and solve problems in electromagnetism using appropriate mathematical technique			
Course Content: Review of vector analysis; Introduction to electrostatics; Boundary-value problems in electrostatics; Electrostatic energy; Electrostatics of macroscopic media; Dielectrics; Electrostatic energy in dielectric media; Magnetostatics; Microscopic theory of the magnetic properties of matter; Magnetic energy; Time-varying fields; Maxwell equations; Conservation laws; Plane electromagnetic waves and wave propagation; Wave guides and resonant cavities; Radiation			
Teaching/Learning Methods: Combination of Lectures, Tutorial discussions, Student-centred discussions			
Assessment Strategy:			
Continuous Assessment (30%)	Final Assessment (70%)		
Details: Quizzes 10, Assignment 10, Attendance 10	Theory 70	Practical N/A	Other (specify) N/A
References/Reading Materials: 1) Griffiths, D. J., (2012), Introduction to Electrodynamics, 4th Edition. Pearson 2) Jackson, J. D., (1998), Classical Electrodynamics, 3rd Edition, John Wiley 3) Lorrain, P., & Corson, D., (1970), Electromagnetic Fields and Waves, 2nd Edition, W. H. Freeman & Co 4) Reitz, R. & Milford, F. J., (2008), Foundations of Electromagnetic Theory, 4th Edition, Addison Wesley			

Semester 7 and 8			
Course Code:	BECS 43818		
Course Name:	Research Project		
Credit Value:	8		
Compulsory/Optional	Compulsory		
Pre-Requisites	All Compulsory courses		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	240	560
Course Aim/Intended Learning Outcomes: At the completion of this course students will be able to demonstrate competence in:			

- planning and carrying out a research project in Electronics
- identifying, defining and investigating a research problem in electronics to provide a solution
- writing a research project plan, documenting progress in detail, and conducting progress reviews
- using suitable electronics principles to solve a research/design problem
- writing a dissertation on the research findings and presenting the results to convince others via effective communication, both in writing and orally
- ethical research practices, and improvement of technical abilities

Course Content:
A group of students will be assigned a research project in Computer Science or Electronics. The project must include identifiable individual components and group components. Initially students have to submit a project proposal and select suitable project supervisor(s). The students' progress will be evaluated regularly by the supervisor and the examination panel. A project report in the form of a dissertation will be submitted at the end of the project.

Teaching/Learning Methods:
PODBL (Project Oriented Design Based Learning) method will be utilized

Assessment Strategy:

Continuous Assessment (100%)	Final Assessment (0%)		
Details: Research proposal (after one month of Level 4) 10, Research progress presentation (at the beginning of Semester 2) 10, Project Demonstration 10, Final oral presentation 20, Dissertation 40, Presentation at symposium 10 (Mini symposium will be organised by the Departments and evaluated by external field experts)	Theory N/A	Practical N/A	Other(specify) N/A

References/Reading Materials:
2) Students must find related references themselves

Semester 7 & 8			
Course Code:	BECS 43043		
Course Name:	Advanced Experimental Laboratory II		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	All the Compulsory courses in Electronics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	N/A	90	60

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:
- demonstrate skills in advanced experimental techniques through laboratory work on power electronics, Microcontrollers, Embedded systems, Control systems, Communication systems, DSP & Image Processing, Advanced Electromagnetism, RF & Microwave Circuits Design, Optoelectronics, Industrial Automation, and FPGAs
- design and plan laboratory experiments on their own
- write comprehensive laboratory reports and present results based on the analysis of experimental data

Course Content:
Power electronics, Microcontrollers, Embedded systems, Control systems, Communication systems, DSP & Image Processing, Advanced Electromagnetism, RF & Microwave Circuits Design, Optoelectronics, Industrial Automation, and FPGAs

Teaching/Learning Methods:
6 hours of laboratory classes per week and independent learning, PODBL (Project Oriented Design Based Learning)

Assessment Strategy:

Continuous Assessment (60%)	Final Assessment (40%)		
Details: Laboratory Reports 50, Attendance 10	Theory N/A	Practical 40	Other (specify) N/A

References/Reading Materials:

1) Students must do literature survey of their own and find suitable references once the goal of the experiment is given to them

Semester 8			
Course Code:	BECS 44053		
Course Name:	Optoelectronics		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 11413 Analogue Electronics		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- understand the nature and characteristics of light
- understand different methods of luminescence, display devices and laser types and their applications
- learn the principle of optical detection mechanism in different detection devices
- understand different light modulation techniques and the concepts and applications of optical switching
- study the integration process and application of optoelectronic integrated circuits in transmitters and receivers

Course Content:

Display devices and lasers: Introduction, Photo luminescence, Cathode luminescence, Electro luminescence, Injection luminescence, LED, Plasma display, Liquid crystal displays, Numeric displays, Laser emission, Absorption, Radiation, Population inversion, Optical feedback, Threshold condition, Laser modes, Classes of lasers, Mode locking, laser applications. Optical detectors: Photo detector, Thermal detector, Photo devices, Photo conductors, Photo diodes, Detector performance. Optoelectronic modulator: Introduction, Analogue and digital modulation, Electro-optic modulators, Magneto optic devices, Acousto-optic devices, Optical, Switching and logic devices. Optoelectronic integrated circuits: Introduction, Hybrid and monolithic integration, Application of optoelectronic integrated circuits, Integrated transmitters and receivers, Guided wave devices

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Saleh, B. & Teich, M., (2007), Fundamentals of Photonics, 2nd Edition, Wiley
2) Kasap, S. O., (2013), Optoelectronics & Photonics: Principles & Practices, 2nd Edition, Pearson

Semester 8			
Course Code:	BECS 44062		
Course Name:	Modern Radar Systems		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 21422 Electromagnetism		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- demonstrate basic understanding of concepts and applications in radar systems
- demonstrate various applications of Radar

Course Content:

Introduction to radar; Detection, Clutter, Filtering, Doppler, Hardware, Electromagnetic propagation, Synthetic aperture radar (SAR), Software defined Radar (SDR), Array beam forming, Space-time adaptive processing, Introduction to target tracking, Tracking algorithms, Radar applications

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions			
Assessment Strategy:			
Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other (specify) N/A
References/Reading Materials: 1) Mark, A. R., (2010), Principles of Modern Radar: Basic Principles, SciTech Publishing			

Semester 8			
Course Code:	BECS 44072		
Course Name:	Physics of Semiconductor Devices		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 11413 Analogue Electronics I, BECS 12462 Mechanics & Properties of Materials		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70
Course Aim/Intended Learning Outcomes: At the completion of this course students will be able to demonstrate: ➢ knowledge of semiconductor band-gap theory. ➢ basic understanding of quantum confinement in semiconductor nanostructures to explain and calculate the band gap shift with size reduction ➢ understanding of the operation mechanism of solar cells, LEDs, lasers and FETs, including the relevant band diagrams to explain their I-V characteristics and functionalities			
Course Content: Review of electronic structure and band structure of semiconductors, Intrinsic and extrinsic semiconductors, Transport properties of semiconductors, Semiconductor devices and their applications, Defects in semiconductors			
Teaching/Learning Methods: Combination of Lectures, Tutorial discussions, Student-centred discussions			
Assessment Strategy:			
Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other (specify) N/A
References/Reading Materials: 1) Sze, S. M. and Ng, K. K., (2006), Physics of Semiconductor Devices, 3rd Edition, John Wiley & Sons 2) Sze, S. M.,(1997), Modern Semiconductor Device Physics, John Wiley & Sons			

Semester 8			
Course Code:	BECS 44082		
Course Name:	Semiconductor device processing and fabrication		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 11413 Analogue Electronics I, BECS 12462 Mechanics & Properties of Materials, BECS 44072 Physics of Semiconductor Devices		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	N/A	70
Course Aim/Intended Learning Outcomes: At the completion of this course students will be able to demonstrate: ➢ basic knowledge of doping, purification, oxidation, gettering, diffusion, implantation, metallization, lithography and etching in semiconductor processing ➢ basic knowledge of x-ray diffraction, SEM and TEM, EDX, Auger, STM and AFM, how they work and what sample information they provide ➢ overall view of semiconductor device fabrication and characterization processes			

Course Content:
Semiconductor characterization techniques, Structural, electrical and optical techniques; x-ray diffraction, photoluminescence, absorption, Raman scattering, SEM, TEM, EDX, Auger, STM and AFM, Bulk semiconductor crystal growth: techniques, defects and properties, Thin film growth: chemical and physical vapour processes, Heteroepitaxy and defects, Substrates and substrate engineering; device fabrication fundamentals: diffusion, ion implantation, oxidation, metallization, Lithography and etching, Device characterization using: Hall effect, four-point probe, *I-V*, *C-V* and optical techniques. Diodes and transistors, Photonic devices; LED, lasers, photoconductors, photodiodes, solar cells, quantum well devices. Recent advances in semiconductor nanostructures research will also be introduced

Teaching/Learning Methods:
Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (20%)	Final Assessment (80%)		
Details: Quizzes 5, Assignment 5, Attendance 10	Theory 80	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Mahajan, S. & Harsha, K. S., (1998), Principles of Growth and Processing of Semiconductors, 1st Edition, McGraw-Hill
2) Mayer, J. W. & Lau, S. S., (1990), Semiconductor Processing: Electronic Materials Science for Integrated Circuits in Si & GaAs, Macmillan
3) Campbell, S. A., (1996), The Science and Engineering of Microelectronic Fabrication, Oxford University Press
4) Shimura, F., (1989), Semiconductor Silicon Crystal Technology, Academic Press
5) Jaeger, R. C., (1988), Introduction to microelectronic fabrication, Addison-Wesley
6) Colliver, D., (1976), Compound Semiconductor Technology, Artech House
7) Sze, S. M., (1988), VLSI Technology, Semiconductor Device Physics: Physics of Semiconductor Devices, 2nd Edition, McGraw-Hill
8) Williams, R. E., (1990), Modern GaAs Processing Methods, Artech House Publishers
9) May, G. S., and Sze, S. M., (2003), Fundamentals of Semiconductor Fabrication, John Wiley & Sons

Semester 7/ 8

Course Code:	BECS 44613		
Course Name:	Data Science		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 44263		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:
At the completion of this course students will be able to:

- describe what is data science and the skill sets needed to be a data scientist.
- explain the basic concepts of statistical inference
- identify probability distributions commonly used as foundations for statistical modeling
- use an appropriate language to carry out basic statistical modeling and analysis.
- explain the significance of Exploratory Data Analysis (EDA) in data science.
- describe the data science process and how its components interact.
- use APIs and other tools to scrap the Web and collect data.
- apply basic machine learning algorithms for predictive modeling.
- identify common approaches used for feature generation.
- identify basic dimensionality reduction algorithms.

Course Content:
Data Wrangling: Static Files, SQL, Web Scraping, APIs and Messy Data; Statistical Inference: Event Space, Probability, Distributions and Hypothesis Testing; Summarizing and Visualizing Data: Descriptive Statistics, Univariate and Multivariate Exploratory Data Analysis; Predictive Modeling: Regression, Classification, Data Preprocessing, Model Evaluation and Ensembles; Data Mining: Dimensionality Reduction, Clustering,

Association Rules, Anomaly Detection, Network Analysis and Recommender Systems; Specialty Topics: Data Engineering, Natural Language Processing, and Web Applications.			
Teaching/Learning Methods: Combination of Lectures, Tutorial discussions, Student-centred discussions			
Assessment Strategy:			
Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 40	Practical N/A	Other(specify) 20 (Project)
References/Reading Materials: 1) O'Neil, C., Schutt, R. (2013). Doing data science: Straight talk from the frontline. O'Reilly Media, Inc.. 2) VanderPlas, J. (2016). Python data science handbook: essential tools for working with data. O'Reilly Media, Inc.. 3) Kelleher, J. D., Tierney, B. (2018). Data science. MIT Press. 4) EMC Education Services (Ed.). (2015). Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data. John Wiley & Sons.			

Semester 7/8			
Course Code:	BECS 44622		
Course Name:	Big Data Technologies		
Credit Value:	2		
Compulsory / Optional	Optional		
Pre-Requisites	BECS 12243, BECS 44283		
Co-Requisites	None		
Hourly Breakdown	Theory	Practical	Independent Learning
	15	45	40
Course Aim/Intended Learning Outcomes: At the completion of this course student will be able to: ➢ describe MapReduce as a computation model and an execution framework ➢ use the big data application stack ➢ compare different tools in the Hadoop stack fit in the big picture of big data analytics ➢ design distributed machine learning algorithms ➢ use cloud computing services (Amazon Web Services) to build your clusters and run large-scale data processing applications ➢ identify and describe the data warehousing concepts and operations.			
Course Content: Big Data introduction: Big data: definition and taxonomy, Big data value for the enterprise, Setting up the demo environment, first steps with the Hadoop ecosystem; The Hadoop ecosystem: Introduction to Hadoop, Hadoop components: MapReduce/Pig/Hive/HBase, loading data into Hadoop, Handling files in Hadoop, Getting data from Hadoop; Querying big data with Hive: Introduction to the SQL Language, from SQL to HiveQL, using Hive to query Hadoop files; Big Data & Machine Learning: Machine learning tools: Spark & SparkML, H2O, Azure ML; Data Warehousing: Data Warehouse introduction, SQL OLAP Extensions, An Algebraic OLAP Operator; Object-Oriented and Object-Relational Databases: Object-Oriented Data Model, Object-Relational Database Systems.			
Teaching /Learning Methods: Combination of Lectures, Tutorial discussions, Student-centred discussions			
Assessment Strategy: Note: Practical examination is compulsory to obtain the final grade in the course.			
Continuous Assessment 40 %	Final Assessment 60 %		
Details: Quizzes 10, Assignments 20, Attendance 10	Theory 40	Practical 20	Other (specify) NA
References/Reading Materials: 1. White, T. (2015). Hadoop: The definitive guide. 4th Edition. O'Reilly Media, Inc.. 2. Mayer-Schönberger, V., Cukier, K. (2013). Big data: A revolution that will transform how we live, work, and think. Houghton Mifflin Harcourt.			

3. Marz, N., Warren, J. (2015). Big Data: Principles and best practices of scalable real-time data systems. New York; Manning Publications Co.
4. Jukic, N., Vrbsky, S., Nestorov, S. (2020). Database systems: Introduction to databases and data warehouses. 2nd Edition. Prospect press.

Semester 7/8			
Course Code:	BECS 44633		
Course Name:	Object-Oriented Analysis and Design		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 12243		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ design and implement projects using Object Oriented concepts
- ➢ model real-world scenarios using UML diagrams
- ➢ apply appropriate software design patterns effectively in large-scale software development
- ➢ generate code from design using an appropriate software tool
- ➢ compare and contrast various testing techniques.

Course Content:

UML Diagrams: Introduction to OOAD, Unified Process, UML diagrams, use case, class diagrams, interaction diagrams, state diagrams, sequence diagrams, activity diagrams, package diagrams, component and deployment diagrams, relationship between different diagrams, logical architecture and its refinements; General Responsibility Assignment Software Patterns (GRASP): Designing objects with responsibilities, creator, information expert, low coupling, high cohesion, controller, polymorphism; Coding and Testing.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions
The use of O-O approach in industry will be discussed by suitable Industrial personnel

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Larman, C. (2004). Applying UML and patterns: an introduction to object oriented analysis and design and iterative development. 3rd Edition. Prentice Hall.
2) Bennett, S., Farmer, R. (2010). Object-oriented systems analysis and design using UML. 4th Edition. McGraw-Hill.
3) Gamma, E., Helm, R., Johnson, R., Vlissides, J. (1994). Design Patterns: Elements of Reusable Object-Oriented Software. 1st Edition. Addison-Wesley.
4) Fowler, M. (2004). UML distilled: a brief guide to the standard object modeling language. 3rd Edition. Addison-Wesley Professional.
5) Jorgensen, P. C. (2013). Software testing: a craftsman's approach. 4th Edition. Auerbach Publications.

Semester 7/8			
Course Code:	BECS 32282		
Course Name:	System Administration		
Credit Value:	2		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 31223, BECS 22233		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	15	30	55

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ describe the structural components of the Unix/Linux and Windows environments
- ➢ carryout installation and configuration of workstations, servers, software and network devices
- ➢ prepare system backup and apply recovery techniques as necessarily
- ➢ create and manage user accounts and groups
- ➢ assess and optimize system/network performance and security.

Course Content:

An overview of the Unix/Linux and Windows OS/servers; Virtual Machine Environment; System startup and shutdown; Server deployments; Installation and configuration network devices and operating systems; Package managers and software installation; Bash Shell/vim editor; Administrator responsibilities and getting help; User/group authentication management; System configuration and management; Period tasks automation; Network file systems and data/system backup techniques; Emergency Recovery; System/Network Monitoring and performance analysis techniques; System/Network security.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Group project, Student-centred discussions

Assessment Strategy:

Continuous Assessment (100%)	Final Assessment N/A		
Details: Assignement 100	Theory N/A	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Limoncelli, T., Hogan, C. J., Chalup, S. R. (2007). The practice of system and network administration. 2nd Edition. Pearson Education.
2) Nemeth, E., Snyder, G., Hein, T. R., Adelstein, T., Lubanovic, B., Limoncelli, T. (2018). UNIX and Linux system administration handbook. USENIX Open Access Policy, 59.
3) Soyinka, W. (2016). Linux Administration: A Beginner's Guide. 7th Edition. McGraw-Hill.
4) 4Mark, B. (2004). Principles of Network and System Administration/Mark Burgess. 2nd Edition. John Wiley & Sons, Ltd.

Semester 7/8

Course Code:	BECS 44643		
Course Name:	Logic Programming		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	30	90

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ demonstrate a deeper understanding of the basic logical concepts
- ➢ implement logic programs for real world problems using an appropriate language
- ➢ explain the notion of formal proof, and construct simple proofs in a natural deduction proof system for predicate logic
- ➢ explain how logic programming differs from other programming paradigms.

Course Content:

Propositional Logic: syntax and semantics, natural deduction proofs, decision procedures; Predicate Calculus: syntax and semantics, natural deduction proofs, undesirability and incompleteness; Logic Programming: Horn fragment of predicate logic, unification and top-down operational semantics, use of a logic programming language, Datalog and bottom up operational semantics; Reasoning about sequential programs: partial correctness assertions, computing weakest preconditions, loop invariants, reasoning about termination.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)

Details: Quizzes 5, Assignment 15, Attendance 10	Theory 50	Practical 20	Other (specify) N/A

References/Reading Materials:

1) Huth, M., Ryan, M. (2004). Logic in Computer Science: Modelling and reasoning about systems. 2nd Edition. Cambridge university press.
2) Bratko, Ivan, (2011), Prolog Programming for Artificial Intelligence, 4th Edition, Pearson Range Extension Paul
3) Sterling, L & Shapiro, E., (1994), The Art of Prolog: Advanced Programming Techniques, 2nd Edition, The MIT Press
4) Saroj, K., (2008), Logic and Prolog Programming, 1st Edition, New Age International Publishers, India
5) Mc Donald, C., & Yazdani, M., (1990), Prolog Programming, 1st Edition, Blackwell Scientific Publications
6) Bramer, M. (2013). Logic programming with Prolog. 2nd Edition. Springer.

Semester 6

Course Code:	BECS 44653		
Course Name:	Image Processing and Computer Vision		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 21223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ demonstrate the steps for solving of image processing/vision problems
- ➢ apply knowledge and understanding of pre-processing, segmentation, description, and recognition
- ➢ choose appropriate methods and implement solutions to small-scale image processing and vision problems.

Course Content:

Overview of Applications of Image Processing and Vision; Digital Image Formats; Colour Models; Data Types; Operators; Manipulating Matrices; File I/O; The Image Processing Toolbox; Thresholding; Histogram Equalization; Linear Filtering (convolution); Noise Reduction; Nonlinear Filtering; Gradients; Edge Magnitude and Direction; Finite Difference Filters; Laplacian of Gaussian Filter; Canny Edge Detector; Colour Transformations; Colour Histogram Equalization; Colour Median Filtering; Colour Gradient and Edge Detection; Thresholding as a form of Segmentation; Basic Global Thresholding; Optimal Global Thresholding; Techniques to improve global thresholding; Region Labeling; Boundary Tracing; Edge Based Segmentation; Region-based Segmentation; Hybrid Methods; Boundary-based measures of accuracy; Region-based measures of accuracy; Measuring Reproducibility; Boundary Descriptors; Region and Shape Descriptors; Texture Description; SIFT Features and Bags of Words; Supervised and Unsupervised Clustering; Nearest Neighbor Classifiers; Bayesian Classification; Training and Testing Methodologies; Morphological Image Processing; Frequency Domain Filtering.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Group and individual projects, Student-centred discussions

Assessment Strategy:

Continuous Assessment (30%)	Final Assessment (70%)		
Details: Quizzes 5, Assignment 15, Attendance 10	Theory 50	Practical N/A	Other (specify) 20 (Project)

References/Reading Materials:

1) Petrou, M. & Petrou, C., (2010), Image Processing: The Fundamentals, 2nd Edition, Wiley
2) Davies, E. R. (2017). Computer vision: principles, algorithms, applications, learning. 5th Edition. Academic Press.
3) Solem, J. E. (2012). Programming Computer Vision with Python: Tools and algorithms for analyzing images. O'Reilly Media, Inc..
4) Hartley, R., Zisserman, A. (2003). Multiple view geometry in computer vision. Cambridge university press.

Semester 6			
Course Code:	BECS 44663		
Course Name:	Theory of Computing		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 21223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ demonstrate the knowledge of advanced concepts of the theory of computing
- ➢ distinguish computing models
- ➢ simulate computing models.

Course Content:

Finite Automata: Deterministic and nondeterministic finite automata, Recursively Enumerable (RE) languages; Regular Expressions and Languages: Criteria for regular languages and expressions, pumping lemma, closure properties of regular languages; Context-Free Grammars and Languages: Context Free Grammars (CFGs), Context Free languages (CFLs), parse trees, and ambiguity in grammars and languages; Pushdown Automata: Pushdown Automata (PDA) and Context-Free Languages (CFLs) and nondeterministic CFLs; Turing Machine (TM): Basic Turing machine, variations of TMs, restricted TMs, TMs and computers; Undecidability: Codes for TMs, diagonalization language, recursive languages, complements of recursive languages and RE languages, universal language, reductions, post correspondence problem; Intractable Problems: Class P, NP and NP complete problems.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Sipser, M. (2007). Introduction to the Theory of Computation. 2nd Edition. Thomson Course Technology.
2) Hopcroft, H. J., Motwani, R., Ullman, D. J. (2007). Introduction to Automata Theory Languages and Computation. 3rd Edition. Pearson Education.
3) Sudkamp, A. T. (2005). Languages and Machines: An Introduction to the Theory of Computer Science. 3rd Edition. Pearson.
4) Martin, C. J. (2014). Introduction to Languages and the Theory of Computation. 2007th Edition. McGraw Hill Education.

Semester 7/8			
Course Code:	BECS 44673		
Course Name:	Theory of Compilers		
Credit Value:	3		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 21223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	40	15	95

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ express the grammar of a programming language
- ➢ develop lexical and syntax analyzers and use them in the construction of scanners and parsers
- ➢ employ the operations of semantic analysis
- ➢ develop a code generator

- ➢ use different compiler optimization schemes in addition to efficient register allocation and garbage collection
- ➢ design and program a complete working compiler for a given language.

Course Content:

Introduction to the structure of a compiler; Lexical Analysis: The role of the lexical analysis, input buffering, specification of tokens, recognition of tokens, finite automata; Syntax Analysis: Context –Free grammars, writing a grammar, top down parsing, bottom up parsing, LR Parsers, parser generators; Syntax Directed Translations: Definitions, applications, syntax directed translation schemes; Intermediate Code Generation: Variants of syntax trees, three-address code, types of declarations, translation of expressions, type checking, control flow, backpatching; Run Time Environments: Storage organization, stack allocation space, heap management, garbage collection; Code Generation: Issues in the design of code generator, The target language, address in the target code, basic blocks and flow graphs, code generation Algorithm, developing a simple compiler.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Cooper, K., & Torczon, L., (2012), Engineering a Compiler, 2nd Edition, Morgan Kauffmann
2) Aho, A. V., Lam, M. S., Sethi, R., & Ullman, J. D., (2006), Compilers Principles Techniques and tools, 2nd Edition, Addison Wesley
3) Mogensen, T. E., (2011),Introduction to Compiler Design (Undergraduate Topics in Computer Science), Springer Verlag London Limited

Semester 7/8

Course Code:	BECS 44682		
Course Name:	Research Methodologies		
Credit Value:	2		
Compulsory/Optional	Compulsory		
Pre-Requisites	BECS 11212		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	25	15	60

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ demonstrate knowledge of qualitative and quantitative research methods
- ➢ explain the ethical considerations in research projects
- ➢ formulate a scientific problem and evaluate relevant information for a scientific problem
- ➢ analyse results with appropriate statistical methods and present results in a scientific manner
- ➢ demonstrate understanding of the opportunities and limitations of science and its role in society and the responsibility for how it is used.

Course Content:

Information gathering; Formulation of aims for a research project; Formulation of scientific problems and hypotheses; Selection of methods for solving a scientific problem; Qualitative and quantitative research methods; Sampling; Statistical analysis; Research Ethics.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Mini Research project, Student-centred discussions

Assessment Strategy:

Continuous Assessment (50%)	Final Assessment (50%)		
Details: Quizzes 10, Assignment 30, Attendance 10	Theory N/A	Practical N/A	Other (specify) 50 (Final Report/Viva)

References/Reading Materials:

1) Kothari, C. R., (2004), Research Methodology: Methods and Techniques, New Age International
2) Kumar, R., (2010), Research Methodology: A Step-by-Step Guide for Beginners, SAGE Publications, Singapore
3) Oates, B. J. (2005). Researching information systems and computing. Sage.

4) Zobel, J. (2015). Writing for computer science. 3rd Edition. Springer.

Semester 7/8			
Course Code:	BECS 44693		
Course Name:	Multimedia Systems Development		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	N/A		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ use appropriate multimedia capturing, authoring and production tools
- ➢ illustrate graphic media file format characteristics
- ➢ discuss concepts of graphic file formats
- ➢ discuss streaming media file format characteristics
- ➢ develop a multimedia product including all multimedia elements.

Course Content:

Introduction to Multimedia: Multimedia and Hyper media, Components of multimedia, Multimedia authoring and tools, Stages of a multimedia project, requirements for multimedia projects; Graphics and Image Representation: Text, Images, Audio and Video representation, Image data types, Colour lookup tables, File formats; Animation: principles of animation, animation techniques, animation file formats; Drawing: 3-D drawing, vector drawing and rendering; Colour in Image and Video: Colour science, Colour models in images, Colour models in video; Lighting: natural light, shading, illumination; Concepts in Video: Types of video signals, Analog video, Digital video, shooting and editing video, non-linear editing; Digital Audio: Digitization of sounds, Quantization and Transmission of audio, Musical Instrument Digital Interface (MIDI); Multimedia Data Compression: Lossless compression algorithms, Lossy compression algorithms, Text and Image compression, Image compression standards, Video compression techniques, Audio compression techniques, MPEG audio and video compression; Practical applications using a suitable multimedia authoring tool, copyright issues; Testing and evaluation of multimedia applications.

Teaching/Learning Methods:

Lectures, Tutorials, Practical, Assignments, Student-centred discussions

Assessment Strategy:

Continuous Assessment (50%)	Final Assessment (50%)		
Details:	Theory	Practical	Other (specify)
Assignment 15, Attendance 10, Project 25	50	N/A	N/A

References/Reading Materials:

1) Li, Z. , Drew, M. S., (2005), Fundamentals of Multimedia, Pearson Education
2) Halsall, F., (2001), Multimedia Communications, Addison-Wesley
3) Andleigh, P. K. & Thakrar, K., Multimedia Systems Design, (1998), Prentice-Hall
4) Vaughan, T. (2011). Multimedia Making it Work. McGraw Hill.
5) Timings, R., Wilkinson, S., Cope, N., Folley, D., Thomson, S. (2005). Multimedia Technology. Longman Pub Group.

Semester 7/8			
Course Code:	BECS 44703		
Course Name:	Natural Language Processing		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 44223		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- describe characteristics of language and its use and understand their implications for Natural Language Processing (NLP) and NLP applications
- explain a broad selection of NLP applications, and describe problems or tasks addressed, materials and methods used, how the applications are evaluated, and opportunities for future developments for each application
- analyze basic NLP tools, and use them to analyze small text corpora
- use benchmark corpora, commercial and open-source text analysis and visualization tools to explore interesting patterns.

Course Content:

NLP: Introduction, Human languages, models, ambiguity, processing paradigms; Phases in NLP; NLP applications; Text representation in computers, encoding schemes; Linguistics resources: Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc, resource management with XML, management of linguistic data with the help of GATE, NLTK; Regular expressions; Finite State Automata; Word recognition; Lexicon; Morphology; Acquisition models; Finite State Transducer; N-grams; Smoothing; Entropy; Hidden Markov Models (HMM); Support Vector Machines (SVM); Conditional Random Fields (CRF); Part of Speech (POS) tagging: Stochastic POS tagging, transformation based tagging in TBL, handling of unknown words, named entities, multi word expressions; Introduction text analytics; Information Extraction; Machine Translation.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Group and individual projects, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other(specify) N/A

References/Reading Materials:

1) Jurafsky, D., Martin, J. H. (2009). Speech and Language Processing. 2nd Edition. Pearson Education.
2) James, A. (1994). Natural language Understanding. 2nd Edition. Pearson Education.
3) Weiss, S. M., Indurkhya, N., Zhang, T. (2010). Fundamentals of Predictive Text Mining. Springer: New York.
4) Manning, C. D., Manning, C. D., Schütze, H. (1999). Foundations of statistical natural language processing. MIT press.
5) Deng, L., Liu, Y. (Eds.). (2018). Deep Learning in Natural Language Processing. Springer.

Semester 7/8

Course Code:	BECS 44723		
Course Name:	Semantic Web and Ontological Modelling		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 22253		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	N/A	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- discuss fundamental concepts, advantages and limits of the semantic web
- use ontologies in the context of Computer Science and the semantic web
- use the RDF framework and associated technologies such as RDF
- discuss the relationship between Semantic Web and Web 2.0

Course Content:

Introduction to the semantic web, Semantic web technologies, Layered approach; Introduction to ontologies, Ontology languages for the semantic web – resource description framework (RDF) – Lightweight ontologies: RDF schema – web ontology language (OWL) – A query language for RDF: SPARQL, Logic and inference: Rules, Ontology engineering, On-to-knowledge semantic web architecture, Semantic web and Web 2.0, Applications of semantic web.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Group and individual projects, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Antoniou, G., Harmelen, F. V., (2008), A Semantic Web Primer, MIT Press
2) Hitzler, P., Krotzsch, M., Rudolph, S., (2009), Foundations of Semantic Web Technologies, CRC Press
3) Allemang, D., Hendler, J., (2008), Semantic Web for the Working Ontologist: Effective Modelling in RDFS and OWL, 1st Edition, Morgan Kauffmann
4) Daconta, M. C., Obrst, L. J., Smith, K. T., (2003), The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management, John Wiley & Sons
5) Powers, S., (2003), Practical RDF, OReilly
6) Passin, T. B., (2004), Explorer's Guide to the Semantic Web, Manning Publications

Semester 7/8			
Course Code:	BECS 44733		
Course Name:	Cloud Computing		
Credit Value:	3		
Compulsory/Optional	Optional		
Pre-Requisites	BECS 12233		
Co-Requisites	N/A		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	NA	105

Course Aim/Intended Learning Outcomes:

At the completion of this course students will be able to:

- ➢ explain and use cloud computing environments
- ➢ apply knowledge of standards in distributed computing, and the impact of standardisation on application programs
- ➢ practice the deployment of cloud computing applications
- ➢ explain the cloudlet architecture.

Course Content:

Fundamentals of Cloud Computing; Concepts and Models; Cloud-enabling Technology; Cloud Security; Cloud Infrastructure Mechanisms; Cloud Management; Cloud deployment; Cloud Computing Architecture; Cloudlet architecture; Parallel programming in the cloud; Virtualization; Distributed storage systems; Cost Metrics and Pricing; Service Quality Metrics and Software License Agreements.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Practical sessions, Group project, Student-centred discussions

Assessment Strategy:

Continuous Assessment (40%)	Final Assessment (60%)		
Details: Quizzes 5, Assignment 25, Attendance 10	Theory 60	Practical N/A	Other (specify) N/A

References/Reading Materials:

1) Erl, T., Puttini, R., Mahmood, Z. (2013). Cloud Computing: Concepts, Technology & Architecture. Prentice Hall
2) Rosenberg, J., Mateos, A. (2010). The Cloud at Your Service: The When, How, and Why of Enterprise Cloud Computing. Manning Publications Co.
3) Rafaels, R. J. (2018). Cloud Computing: From Beginning to End. 2nd Edition. CreateSpace Independent Publishing Platform.

Semester 7/8			
Course Code:	BECS 44743		
Course Name:	System Level Programming		
Credit Value:	3		
Compulsory / Optional	Optional		
Pre-Requisites	BECS 22233		
Co-Requisites	None		
Hourly Breakdown	Theory	Practical	Independent Learning

	30	45	75

Course Aim/Intended Learning Outcomes:

At the completion of this course student will be able to:

- understand the history, attributes and architecture of UNIX Operating System.
- identify the usage of various commands and utilities in UNIX environment.
- interact with UNIX system and UNIX editors for various tasks.
- write Shell scripts using essentials in Shell programming.
- design and Implement Shell functions to solve various problems.
- use a low-level language (C) to interface with an operating system (UNIX).

Course Content:

Introduction to the UNIX Operating System, UNIX Environment and Architecture, Attributes and Varieties of UNIX, Basic UNIX Commands and Utilities.

Files: UNIX file system, Creating, listing, editing, and deleting Files, Directory Management, File system calls and File permissions: File and Directory Access modes, chmod, Changing Permission.

Processes: Basic concepts, daemon processes, process creation and termination, process diagnostics (ps, kill, top), Filters: head, tail, sort, Filters using regular expressions – grep, egrep, sed and awk.

Scripting Shell Scripting, Shell Types: Bourne, Korn and Bash, Shell Programming: Variables, Arrays, Decision Making, Loops and Functions, use a low-level language (C) to interface with an operating system (UNIX) and UNIX editors.

Teaching/Learning Methods:

Combination of Lectures, Tutorial discussions, Group and individual projects, Student-centred discussions

Assessment Strategy:

Continuous Assessment 40%	Final Assessment 60%		
Details: Class Test 05, Spot tests & Assignments 25, Attendance 10	Theory (%) 40%	Practical (%) 20%	Other (%)(specify) NA

References/Reading Materials:

1. Glass, G., & Ables, K. (2003). UNIX for Programmers and Users. Pearson Education India.
2. Das, S. (2006). UNIX, Concepts and Applications. Tata McGraw-Hill.
3. Forouzan, B. A., & Gilberg, R. F. (2003). UNIX and Shell Programming: A Textbook. Cengage Learning.
4. Venkateshmurthy, M. G. (2009). Introduction to Unix and Shell Programming. Pearson Education India.